The Danish Pest Infestation Laboratory conducts research and experimental tests while accumulating knowledge on pests harmful to livestock, barns, storage houses, buildings and material used.

Furthermore, the laboratory aims at accomplishing optimum control while still watching out for any adverse effects on the environment.

Main research areas are: chemical control, alternative control, prevention, pest biology and behaviour, pesticide resistance, medical and veterinary problems caused by pests and by the environmental impacts of pesticides.

Furthermore, the Danish Pest Infestation Laboratory offers advisory services with a view to solving particularly complicated problems relating to pests on agricultural property, in dwellings and in the food industry.

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Danish Pest Infestation Laboratory Annual Report 1997

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Forord

Det er mig en glæde at præsentere laboratoriets årsberetning 1997.

Laboratoriets økonomi er fortsat stabil og tilfredsstillende med en god fordeling mellem basisbevilling og eksternt finansierede aktiviteter. Laboratoriet vil tilstræbe, at denne fordeling fastholdes, fordi det giver en god balance mellem strategisk forskning og mere anvendelsesorienteret forskning.

Projekterne vedrørende forskning i biologisk og mikrobiologisk bekæmpelse og biokemiske mekanismer bag pesticidresistens forløber tilfredsstillende, og resultaterne begynder nu at blive publiceret. Begge programmer gennemføres i samarbejde med Den Kgl. Veterinær- og Landbohøjskole og Statens Planteavlsforsøg, resistensforskningen tillige i samarbejde med Roskilde Universitetscenter. Til begge programmer er der knyttet Ph.D.-uddannelse. Foruden et igangværende Ph.D-projekt om gnavere og biologisk bekæmpelse i Danmark påbegyndtes endnu et lignende projekt i Tanzania, og der er udsigt til, at endnu et Ph.D.-projekt om gnaverresistens kan igangsættes til næste år. Laboratoriet vil prioritere forskeruddannelse højt og tilstræbe, at fremtidige projekter giver mulighed for tilknytning af Ph.D.-studerende.

Det høje aktivitetsniveau mærkes på pladsforholdene. Det er mit håb, at der i fremtiden vil blive mulighed for at øge laboratoriets arbejdsareal gennem om- og tilbygning.

Til slut bringes en tak til bestyrelsen og alle medarbejdere for et godt samarbejde i det forløbne år.

N. Bille

Dansk resumé af den engelske årsberetning

(SSL= Statens Skadedyrlaboratorium)

Der henvises til den engelske tekst for en nærmere omtale af de enkelte afsnit (se indholdsfortegnelsen).

Internationalt samarbejde

Årsberetningen indledes med en omtale af det internationale samarbejde, der spiller så stor en rolle for SSLs virke både med hensyn til at udveksle informationer og ideer, og ved at SSL yder rådgivning og undervisning til folk i andre lande og internationale organisationer.

En række medarbejdere deltog i 1997 i internationale konferencer eller kongresser i Schweiz, England, U.S.A. og Mexico.

Arbejde for WHO. SSL er “WHO Collaborating Centre on Pesticide Resistance”, og J. Keiding har siden 1962 været medlem af “WHO Expert Panel of Vector Biology and Control”. J. B. Jespersen blev i 1991 også udpeget som medlem af dette panel.

Arbejde for EPPO. Siden oktober 1994 har J. Lodal været permanent medlem af EPPO Rodent Control Panel.

Arbejde for EU. Siden 1988 har J. B. Jespersen været medlem af SEMG, som er en videnskabelig styringsgruppe for udvikling og implementering af bæredygtig husdyrproduktion i udviklingslande. Fra 1991 har J. B. Jespersen været medlem af en Cost Action vedrørende bekæmpelse af bremselarver; indsatsen afsluttes i 1998 med en rapport udgivet af EU. I 1996 opnåedes støtte til en Concerted Action med henblik på at udvikle og implementere strategier til forebyggelse af insekticid- og acaricid-resistens i Europa. Indsatsen løber i 2½ år og involverer 12 europæiske lande samt industriens repræsentanter og ledes af J. B. Jespersen.

Undervisning

I lighed med tidligere år har laboratoriet afholdt kurser om skadedyr og skadedyrbekæmpelse: muldvarpebekæmpelse og gnaverbekæmpelse. Endvi-dere har laboratoriet holdt foredrag for grupper af kolleger og studerende.

Konsultationen

Bemærkelsesværdige enkeltsager og karakteristiske variationer i antallet af henvendelser i 1997

På grundlag af en meget lille nedbørsmængde i januar-marts, forventede vi, at antallet af **stikmyg, *Culicidae*** ville blive lavt. Megen nedbør i løbet af maj rettede dog op på denne situation, og forekomsten af stikmyg i 1997 blev meget normal.

Tysk kakerlak, *Blattella germanica*, har de sidste tre år været registreret i et meget lavt antal. I 1997 fik vi 111 henvendelser vedrørende dette dyr, hvilket må betegnes som normalt. Den varme sommer med meget høje temperaturer i juli og august har givetvis også favoriseret kakerlakkernes udvikling.

I august måned blev vi præsenteret for et formodet skadedyrsproblem i forbindelse med importerede tagrør fra Tyrkiet. Tækkemændene, der håndterede tagrørene, udviklede kraftigt hududslet (dermatitis). En lignende beskrivelse modtog vi i 1996, hvor beboerne i et hus med et nytækket stråtag havde samme problemer. I begge tilfælde har vi ikke i stråene kunnet konstatere skadedyr, der skulle forårsage dermatitis.

Iberisk skovsnegl, *Arion lusitanicus*, optrådte på enkelte lokaliteter i et stort antal først i september, hvilket medførte, at de blev præsenteret i TV. Dette bevirkede, at vi blev kontaktet af en del bekymrede personer, der mente, at de havde denne snegleart i haven, hvor den kan være et alvorligt skadedyr. Den er dog kendt fra flere lokaliteter i Danmark, uden at den på disse steder har vakt opsigt, hvilket betyder, at den ikke i alle tilfælde skaber problemer.

Hovedlus, *Pediculus capitis,* var i år på samme høje niveau som forrige år. Henvendelser omkring hovedlus var tidligere særligt talrige efter længere skoleferier. Dette billede er tilsyneladende ved at ændre sig, så henvendelserne er mere jævnt fordelt over hele året. Apotekere, sundhedsplejersker, pædagoger og forældre melder om et stigende antal børn, der får hovedlus flere gange i løbet af et år. Ofte er det mistanke om, at lusebekæmpelsesmidlerne ikke længere virker, der får dem til at henvende sig. Der er ikke lavet undersøgelser i Danmark, der kan klarlægge baggrunden for de stigende problemer med hovedlus. Vejledning omkring den korrekte brug af bekæmpelsesmidlerne og oplysninger om mulige smitteveje og lusenes levevis er vigtig i forbindelse med bekæmpelse af hovedlus.

Tofarvet frømøl, *Plodia interpunctella,* blev i år registreret i det højeste antal nogensinde. Denne art udgør ca. 40% af henvendelserne om skadedyr i fødevarer og har været stigende i antal gennem en længere årrække. Det drejer sig i langt de fleste tilfælde om private borgere, der har haft angreb af tofarvet frømøl i produkter, der indeholder nødder, mandler eller tørrede frugter. Der er ingen umiddelbar forklaring på stigningen i antallet af henvendelser. Det kan skyldes, at private hjem i langt højere grad end tidligere spiser produkter, hvori disse møl trives. Nogle meget varme sommermåneder kan ligeledes være en del af forklaringen på det rekordhøje antal henvendelser i år.

Stor gedehams, *Vespa crabro,* har siden 1993 ikke været registreret i samme høje antal, som det er tilfældet i år. Antallet af de mindre gedehamse har derimod ikke været højere end i de foregående år.

Kattelopper, *Ctenocephalides felis,* er de sidste to år blevet registreret i et væsentligt lavere antal end tidligere. Det kan skyldes, at brugen af forebyggende loppemidler er blevet meget mere udbredt, efter at nye midler kom på markedet i 1995.

Undersøgelser og afprøvninger

Insektafdelingen

Stuefluer. Tre nye aktivstoffer til bekæmpelse af stuefluer blev undersøgt med henblik på at fastslå midlernes effektivitet og eventuelle kryds-resistensproblemer. Undersøgelserne involverede bioassays i form af dråbe- og fodertests med et større antal af laboratoriets resistente og følsomme stammer af stuefluer.

Danske stuefluers resistens. I 1997 foretoges en stikprøveundersøgelse af resistens mod de vigtigste midler, der anvendes i Danmark. Der indsamledes fluer på 21 gårde. Afkommet blev testet for kontaktresistens mod bioresmethrin/pb og pyrethrin/pb som repræsentant for de aktive stoffer i aerosoler og forstøvningsmidler og mod dimethoat. Ligeledes blev der udført fodringstest med de tre anvendte smøremidler, azamethiphos, propetamphos og methomyl samt larvicidtest med diflubenzuron og cyromazin. Som noget nyt blev alle de indsamlede stammer også testet ved hjælp af nyudviklede biokemiske assays med henblik på at fastslå de mekanismer, der forårsager resistensen.

Resultaterne viste en svagt stigende resistens mod pyrethroider og azamethiphos. Resistensen mod dimethoat er stadig udbredt. Der var tegn på begyndende resistens mod larviciderne diflubenzuron og cyromazin. For yderligere oplysninger henvises til det engelsksprogede afsnit.

Laboratoriets samling af resistente fluestammer udgjorde ved årets udgang 22 stammer. Disse repræsenterede et bredt udsnit af resistensmekanismer og oprindelser. Stammerne anvendes til undersøgelse af nye midler og resistensforskning i ind- og udland. Detaljerede oplysninger om de enkelte stammer kan ses i Tabel 6a i det engelsksprogede afsnit.

Biologisk bekæmpelse af stuefluer og stikfluer med snyltehvepse. Stuefluer og stikfluer kan ved høje koncentrationer virke yderst generende overfor mennesker og dyr nær landbrugsbedrifter. Ligeledes kan fluerne overføre forskellige sygdomme og nedsætte husdyrenes tilvækst samt mælkeydelse.

Til bekæmpelse af stuefluer og stikfluer anvendes normalt en række forskellige kemiske midler, der i de fleste tilfælde er virksomme, men undersøgelser har vist, at fluerne hurtigt udvikler resistens over for mange af produkterne. Dertil kommer så et stigende ønske fra befolkningen og fra politisk side om, at landbruget reducerer brugen af miljøbelastende midler. Fødevareministeriet har derfor støttet et femårigt projekt, der har til formål at undersøge mulighederne for at anvende snyltehvepse på fluepuparier som alternativ eller supplement til de kemiske midler.

Første skridt i projektet har været at undersøge hvilke snyltehvepse, der er aktive, hvornår de er aktive, samt hvor effektive de er på grise- og kvæggårde. Undersøgelsen viser, at flere arter af snyltehvepse er aktive i løbet af sæsonen, og at deres aktivitet topper sidst på sommeren, hvor fluernes antal er aftagende på grund af faldende temperaturer samt skimmelsvampe. Ligeledes viste undersøgelsen en begrænset effekt af snyltehvepse som dødelighedsfaktor over for fluer i stalde og møddinger.

Enkelte arter af snyltehvepse er udvalgt til videre undersøgelser for at finde en egnet kandidat til opformering og masseudsætning i stalde. Der er samtidig taget iniatiativ til undersøgelse af udsætningsstrategier for at finde det optimale tidspunkt, samt antal hvepse der skal udsættes i en stald, for at fluetallet bliver reduceret til et acceptabelt niveau.

Entomophthora muscae. Den insektpatogene svamp *Entomophthora muscae* optræder ind imellem med meget høj prævalens om sommeren, uden at det øjensynligt påvirker tætheden af stuefluen *Musca domestica*. Denne undersøgelse blev iværksat for at undersøge påvirkningen af besætningstype og årstid på forekomsten af *E. muscae*.

I løbet af august, september og oktober 1997 blev henholdsvis 10, 10 og 13 gårde besøgt fordelt på 16 kvæggårde, 9 svinegårde og 8 gårde med blandet brug. Stuefluer blev indsamlet og sat op enkeltvis i medicinbægre med sukkeragar. Prævalensen blev opgjort efter 10 dage.

Der blev fundet signifikant færre inficerede stuefluer fra svinebesætninger, hvor der de fleste steder blev anvendt varmelamper. Det kan tyde på, at stuefluen udfører “behavioural fever” - dvs. kurerer sig selv for sygdommen ved at opsøge de op til 45°C, der findes på lampernes overflade. Derudover blev der fundet signifikant højere prævalens senest på året.

Mikrobiologisk bekæmpelse af fluer på græssende kreaturer. I projektet undersøges den naturlige forekomst af insektpatogene svampe i forskellige fluearter tilknyttet græssende kreaturer, og svampenes potentiale som bekæmpelsesmidler evalueres. Fluer fra græssende kreaturer blev indsamlet på seks lokaliteter fra juli til september. Fluerne blev inkuberet i papbure med adgang til blod, vand og mælkesukker, og døde fluer blev undersøgt for forekomst af svamp. De hyphomycete svampe *Beauveria bassiana* og *Verticillium lecanii* blev isoleret fra nogle få fluer fra hver af lokaliteterne. Mod forventning blev der ikke fundet fluer angrebet af *Entomophthora muscae* eller andre svampe fra *Entomophthorales*. Dette var overraskende, fordi der synes at være adskillige muligheder for smitteoverførsel til stede på græsningsarealerne; f.eks var der på en lokalitet en epizooti af *E. muscae* i forskellige fluearter. Fluer med sporulerende svampe sad fikseret på bladundersider på tidsler, og samme sted blev observeret levende stikfluer m.fl. i hvile. Ganske få svampeangrebne stikfluer og kvægfluer er fundet på andre lokaliteter; indtil videre synes svampene dog ikke at være væsentlige mortalitetsfaktorer.

Pilotforsøg med lille stikflue og kvægflue viste, at begge arter fluer nemt inficeres med svampe som *B. bassiana*, *Paecilomyces fumosoroseus* m.fl.

Fluer på græssende kreaturer. I samarbejde med en række europæiske laboratorier og universiteter har Statens Skadedyrlaboratorium arbejdet med, hvordan fluer tiltrækkes af deres værter, og specielt hvilke forskelle der er mellem de kvier, der tiltrækker mange fluer, og dem der ikke gør det. I forlængelse af dette gennemførte vi i 1997 en række eksperimenter. Vi testede seks forskellige kemiske stoffer for deres evne til at tiltrække eller afskrække fluerne på græssende kvier. To flokke med syv dyr i hver blev brugt. Inden forsøget blev iværksat, blev antallet af fluer på de enkelte kvier talt, og flokkene blev sammensat således, at der både var kvier, der var gode til at tiltrække fluer, og nogle der var dårlige til at tiltrække fluer i hver flok. I forsøgene blev to kvier i hver flok udstyret med en rem om livet, hvorpå der var monteret en stålcylinder med huller i, hvori det stof, der skulle undersøges, blev placeret. Stoffet fandtes i en svamp, der var indpakket i en "plastikpose", gennem hvilken teststoffet kunne dampe med en ganske bestemt hastighed. Effekten på fluebelastningen blev dernæst undersøgt ved at optælle antallet af plantagefluer, af den lille stikflue, af efterårsstikfluen, af kvægfluen og af regnklæg 6 gange i løbet af dagen.

Baseret på dette kunne det konstateres, at der ikke kunne opnås nogen effekt med de fire testede stoffer, mens to syntes at have en vis afskrækkende virkning på fluerne. Når stofferne blev anvendt på dyr, der normalt havde høje fluetal, så faldt antallet af fluer på dem, mens antallet på de andre i flokken steg.

Resistens i danske kakerlakpopulationer. Tyske kakerlakker indsamlet fra fire feltlokaliteter samt to af laboratoriets stammer blev brugt i en undersøgelse af kakerlakresistens (se tabellen i afsnit 8.2). Kakerlakkerne blev behandlet med forskellige doser af henholdsvis permethrin og chlorpyrifos, og deres følsomhed over for disse to aktivstoffer kunne således bestemmes. I laboratoriet blev der målt på en række enzymsystemer hos de samme kakerlakstammer, og det kunne vises, at der var et næsten fuldkomment sammenfald mellem den generelle esteraseaktivitet og størrelsen af chlorpyrifos-resistensen. En tilsvarende sammenhæng blev ikke fundet i forbindelse med AChE-aktiviteten. Der blev ikke fundet nogle sammenhænge mellem phyrethroid-resistensen og de målte enzymaktiviteter. Den påviste begyndende nedsatte følsomhed overfor chlorpyrifos kan give anledning til nogen bekymring; chlorpyrifos-baserede produkter har haft stor betydning for, at kakerlakproblemerne i Danmark har kunnet holdes på et lavt niveau.

Insektpatogene svampe til bekæmpelse af tyske kakerlakker. Virulensen af svampene *Metarhizium anisopliae* og *Paecilomyces fumosoroseus* blev sammenlignet i bioassays, hvor nymfer, hanner og hunner blev inokuleret med forskellige doser af svampesporer i vandig opløsning. Insekterne blev herefter inkuberet enkeltvis i plastikbægre med adgang til vand og foder. *M. anisopliae* var den mest virulente art, selvom den oprindeligt blev isoleret fra en bille, mens *P. fumoso-roseus* er isoleret fra en tysk kakerlak. For begge svampearter gælder, at hunner var mere modtagelige for infektion end hanner. Igangværende undersøgelser med andre isolater af de to svampe vil vise, om dette gælder generelt for disse svampearter. Desuden undersøges sporeproduktionen af svampeisolaterne, idet *P. fumosoroseus* producerer markant flere sporer end *M. anisopliae*, og sporer af *P. fumosoroseus* synes også lettere at frigøres fra sporulerende kadavere. Dette kan have betydning for spredningen af de to svampe mellem forskellige individer.

Egernloppen. *Ceratophyllus sciurorum sciurorum*. Samarbejdet med University of Leicester (Frank Clark, Derek Deadman) og University of Loughborough (Malcolm Greenwood), England, om at undersøge forskellige aspekter omkring døgnrytmer og andre former for adfærd hos lopper fortsatte i 1997. I årets løb har vi koncentreret os om at vise, hvorledes fødeoptagelse påvirkede døgnrytmen. Det viste sig, at lopper, der har fået et blodmåltid, stadig har en døgnrytme i sine aktiviteter, men de er aktive i kortere tid end lopper, der ikke har fået sig et blodmåltid.

Katteloppen. *Ctenocephalides felis*. I 1997 testede vi et produkt, CGA 246'916, til bekæmpelse af voksne kattelopper på katte. CGA 246'916 indgives oralt til katte. Effekten af denne behandling blev sammenlignet for katte, der også fik en lufenuron behandling, katte der kun fik CGA 246'916, og katte der ikke fik nogen form for behandling. Der observeredes en hurtig og total bekæmpelse af lopperne i begge de to grupper af katte, der fik CGA 246'916. Holdbarheden af behandlingen er kortere end fem dage. Hvor kort kunne ikke ses præcist, men der blev foretaget en succesfuld reinfestation med lopper på kattene fem dage efter den her foretagne ugentlige behandling med CGA 246'916.

Kyllingemiden. *Dermanyssus gallinae.* En spørgeskemaundersøgelse omfattende ca. 400 danske ægproducenter viste, at sammenlagt havde ca 1/3 af producenterne kyllingemider. Den laveste forekomst (14%) blev set hos de økologiske ægproducenter, men dette skyldes sandsynligvis, at disse kun var 3 år gamle i gennemsnit. I modsætning til den normale opfattelse havde en relativ stor del (28%) af burægsproducenterne også mider. Problemerne med mider er generelt stigende gennem sommeren for at kulminere i juli og august, og de mest almindelige problemer, som miderne forårsagede, var mere urolige høns og øget fjerpilning.

I 1997 er påbegyndt undersøgelser af, hvordan forskellige fysiske stimuli påvirker kyllingemidens adfærd, specielt med henblik på at undersøge hvordan miden kan opdage, at en potentiel vært er i nærheden. De værts-relaterede stimuli er: CO_2, varme og rystelser af underlaget. De foreløbige resultater tyder på, at disse stimuli er ret effektive. Undersøgelserne fort-sætter i 1998.

Det er velkendt, at kyllingemider udskiller et duftstof, som får andre mider til at samles. Forsøg på at isolere dette duftstof blev påbegyndt i 1997. Afvaskninger af glasrør, som miderne havde gået i gennem længere tid, blev brugt som ekstrakt. Ekstraktet blev separeret ved hjælp af papir-kromatografi, og de aktive bestanddele blev lokaliseret ved at anbringe mider på det tørre stykke papir, hvorefter miderne samler sig det sted, hvor duftstoffer findes. Dette viste sig at være en brugbar metode, men separation med papirkromatografi er ikke særlig effektiv, og derfor vil denne metode blive erstattet med tyndtlagskromatografi (TLC) i de videre undersøgelser i 1998.

Biller i slagtekyllingestalde. Forekomst af biller i slagtekyllingestalde er anledning til voksende bekymring på grund af deres evne til at fungere som reservoir for f.eks. salmonellabakterier. I samarbejde med Statens Veterinære Serumlaboratorium, Dansk Slagtefjerkræ, dyrlæger og produ-center gennemfører vi derfor for øjeblikket en undersøgelse af disse billers biologi, forekomst og betydning. Undersøgelserne vedrørende biologi og følsomhed er næsten afsluttet, mens undersøgelserne vedrørende billernes betydning forventes afsluttet i 1998. I 1998 vil billernes eventuelle resistens mod de almindeligst anvendte insekticider også blive undersøgt.

Insektpatogene svampe til bekæmpelse af melbiller i fjerkræstalde. En tidligere screening af forskellige insektpatogene svampe over for larver af lille melbille viste, at dette skadedyr inficeres af de fleste isolater af hyphomyceter, bl.a *Beauveria bassiana* og *Metarhizium anisopliae*.

Undersøgelser bekræftede, at larver og pupper er betydeligt mere modtagelige for infektion end voksne melbiller. Resultater fra bioassays viste, at det var muligt at udvælge svampeisolater, som ikke blot var virulente over for larver, men også havde en relativ høj virulens over for voksne biller. Disse svampeisolater testes fremover i burforsøg, for at deres spredningspotentiale i melbillebestande kan undersøges.

Insektpatogene nematoders egnethed til bekæmpelse af skimmelbillen *Typhaea stercorea* i kyllingestalde. Fire arter af insektpatogene nematoder blev testet mod larver og biller af skimmelbillen *Typhaea stercorea* på filterpapir. Den mest effektive art, *Steinernema carpocapsae*, blev efter-følgende testet mod voksne biller i fodersubstrater af vådt kyllingefoder eller knækket hvede blandet med fibertexmåtte. Disse substraters evne til at tiltrække og dræbe biller blev afprøvet i rørfælder placeret i strøelse hentet fra en kyllingestald. Selv om tiltrækningen af billerne var ringe, viste resultaterne, at nematoderne ved høj luftfugtighed var i stand til at overleve i fodersubstraterne og at inficere billerne deri. Substraternes tiltræknings-kraft og evne til at bevare fugtighed skal forbedres, før insektpatogene nematoder kan bruges som biologisk bekæmpelsesmiddel i rørfælder mod skimmelbiller i kyllingestalde.

Kemisk bekæmpelse af forældredyrsflokke. I forældredyrsflokke forårsager store billepopulationer ofte problemer i form af ødelæggelse af isoleringen og deres evne til at fungere som reservoir for smittekim. I 1997 forsøgtes sådanne billepopulationer bekæmpet i en større forældredyrsflok ved anvendelse af et nyt larvicid enten alene eller i kombination med to forskellige midler til bekæmpelse af de voksne biller. Effekten af bekæmpelsen blev vurderet hveranden uge året igennem ved hjælp af rørfælder. Alle tre bekæmpelsesstrategier var succesfulde.

Træskadedyr. Projektet “Almindelig borebille i museumsgenstande og historiske bygninger - forebyggelse og bekæmpelse” blev afsluttet med en analyse af data fra tre års målinger af borebilleaktivitet og klimaforhold i ni landsbykirker. Til trods for, at der kun var meget lille borebilleaktivitet i loftskonstruktionerne, var den højest i de kirker, hvor der blev målt den højeste træfugtighed. Projektet har resulteret i udarbejdelse af anvisninger på forbedrede metoder til vurdering af borebilleaktivitet i trækonstruktioner. Dansksproget rapport over projektet vil foreligge i 1998.

Skadedyrallergener i korn og kornprodukter. De indsamlede data i dette projekt er blevet viderebearbejdet i 1997 og indgår i C. Danielsens Ph.D.-afhandling, som vil blive afleveret i 1998. Man har i denne fase koncentreret sig om resultaterne fra et laboratorieforsøg, som skulle belyse betydningen af temperatur og fugtighed på udviklingen af kornmiden *Lepidoglyphus destructor* i hel hvede. Midepopulationens vækstrate blev bestemt ved hjælp af en simuleringsmodel. Ved 5-20°C lå vækstraten mellem 0,0009 og 0,13 mider pr. dag. Høj relativ luftfugtighed (83-90%) og temperaturer på 16-22°C blev fundet som de optimale værdier ved hjælp af en lineær statistisk model.

I laboratorieforsøgene indgik desuden måling af koncentrationen af et major-allergen fra miden, *lep d* 2 (tidligere *lep d* 1) ved hjælp af ELISA. Det blev fundet, at temperatur og tid har signifikant betydning (R^2=59%) for koncentrationen af allergen, men i lighed med andre forsøgsserier i dette projekt konkluderes det, at ELISA-metoden kræver en del forbedringer, før den kan anvendes kommercielt.

Biologisk bekæmpelse af melmøl i møllerier. Projektet har til formål at afdække mulighederne for at anvende naturlige fjender til bekæmpelse af melmøl i industrimøller.

Der er på basis af publicerede data over melmøllenes biologi udviklet en matematisk model, der beskriver udviklingen af melmølbestande i møllerier. Modellen blev efterprøvet ved sammenligning med data fra tre års undersøgelser i en mølle. Temperaturen i møllen blev anslået til at være 5°C højere end udetemperaturen. Modellens beregninger af melmøllenes populationsudvikling viste sig at ligge tæt på det observerede; på basis af modellen er det beregnet, at 1-3% af den mulige årsproduktion af melmøl bliver til voksne møl det følgende år.

Klimaet i to industrimøller er kortlagt igennem et år. I visse områder af møllen ligger temperaturen ca. 5°C over udetemperaturen - her blev målt gennemsnitstemperaturer på 3-30°C. I andre områder lå gennemsnitstemperaturen konstant over ca. 15°C på grund af varmeudvikling fra maskiner. Dette afspejlede sig i forekomsten af melmøl fanget i feromonfælder. I de varme områder blev der fanget melmøl fra februar, hvor moniteringsprogrammet startede, mens der i køligere områder først forekom melmøl i juni.

To naturlige fjender er udvalgt til videre undersøgelser: en rovmide, *Blattisocius tarsalis,* og en snyltehveps, *Trichogramma evanescens*. Begge arter angriber ægstadiet af melmøl. De er begge etableret i laboratoriet med henblik på yderligere undersøgelser. *Blattisocius tarsalis* er blevet grundigt undersøgt i 1997. Arten er fundet i et betydeligt antal på voksne melmøl indsamlet på en dansk melmølle. Den er således naturligt forekommende her i landet. I laboratorieforsøg er sammenhængen mellem temperatur, byttedyrstæthed og prædationsraten blevet fastlagt. Ved 15°C er prædationsraten af en sådan størrelse, at denne rovmide kan siges at være en lovende kandidat til biologisk bekæmpelse af melmøl. Rovmiden angriber alle aldersklasser af melmølæg; den er en overfladeprædator, der ikke trænger ned i melet.

IPM i industrimøller. Projektet, der blev bevilget i december 1997, har til hensigt at udarbejde og iværksætte hensigtsmæssige, individuelt designede IPM-strategier på 3 danske industrimøller. Møllerierne har i skadedyrsbekæmpelsen hidtil i stort omfang benyttet sig af gasninger med methylbromid. Methylbromid bliver omfattet af et totalforbud i Danmark pr. 1. januar 1998, og møllerierne må derfor i fremtiden basere bekæmpelsen af insektskadedyr på en kombination af andre kemiske og alternative bekæmpelsesmetoder. Projektet er et samarbejdsprojekt mellem Statens Skadedyrlaboratorium, møllerierne og desinfektørfirmaer.

Bekæmpelse af skadedyr i museer. (Fortsættelsen af forsøgene rapporteret i årsberetningen for 1996). To insekticider (α-cypermethrin og mikro-indkapslet diazinon) blev udvalgt til undersøgelse af mulighederne for at beskytte tekstiler mod skadedyr ved at anvende insekticidbehandlet pakkemateriale. Uldklæde blev indpakket i to stykker ubehandlet silkepapir og dernæst enten 1) pakket i behandlet silkepapir, 2) lagt i en æske behandlet på ydersiden eller 3) lagt på en behandlet træhylde og udsat for larver af fem arter af klannere (*Anthrenus verbasci, Attagenus unicolor, Attagenus museorum, Reesa vespulae* og *Trogoderma angustum)*. Efter et års lagring kunne α-cypermethrin-formuleringen ikke yde tilstrækkelig beskyttelse, når det blev brugt på behandlede hylder og på behandlede æsker. Derimod var der god effekt, når der blev anvendt behandlet silkepapir til indpakning. Der var enkelte mindre skader også i dette forsøg, men kun når vi brugte *Anthrenus verbasci* som testdyr. Resultaterne med diazinon-formuleringen vil først forelægge i 1998.

I projektet vedrørende anvendelse af lavt ilttryk til bekæmpelse af skadedyr i museumssammenhænge er der gennemført to forsøgsserier, hvor forsøgsdyr eksponeres for max. 0,3% ilt i et klimakammer ved 25°C og 55% relativ luftfugtighed. Undersøgelserne gennemføres så vidt muligt på alle stadier af dyrene. Behandlingstider varierer mellem 6 og 72 timer. De foreløbige re-sultater tyder på, at klannerarterne *Anthrenus verbasci, Ptinus tectus* og *Trogoderma angustum* er mindre følsomme end *Ant. museorum*.

Pattedyrafdelingen

Bromadiolon voksblok i en ny formulering blev tilstrækkeligt godt accepteret af brune rotter til brug for bekæmpelse.

Bromadiolon som drikkegift blev undersøgt i en forsøgsserie, hvor der til syv forskellige formuleringer var tilsat forskellige aromastoffer, som blev sammenlignet med én uden aromastof. Der var ingen væsentlige forskelle mellem de i alt otte forskellige formuleringer med hensyn til rotternes eventuelle præference. Mortaliteten var for lav til brug i bekæmpelses-øjemed. Det samme var tilfældet i en anden forsøgsserie med en bromadiolon-drikkegift.

Difenacoum pasta blev i en forsøgsserie fundet egnet til rottebekæmpelse.

Gips i en formulering med havregryn viste ikke nogen effekt som rottegift.

Resistensundersøgelserne med den brune rotte omfattede 496 indsendte rotter. Der blev fundet resistens mod coumatetralyl i fem nye kommuner og mod bromadiolon i tre nye kommuner.

En rottefælde udviklet af en dansk opfinder blev i en række prototyper undersøgt over for rotter med henblik på en optimal konstruktion og virkemåde. I fælden dræbes rotter med CO_2, og det blev konstateret, at koncentrationen af CO_2 skulle være over 60% i atmosfærisk luft for at virke dræbende tilstrækkeligt hurtigt.

Pattedyr, der eventuelt krydser den kommende Øresundsforbindelse, kan tænkes at forvolde direkte skader på anlæggene og eventuelt overføre sygdomme mellem Danmark og Sverige. Sådanne potentielle problemer er blevet evalueret.

Prædatortrykkets betydning for markmus blev undersøgt i feltforsøg. Foreløbige dataanalyser viser dog højere overlevelse, mere positiv vægtudvikling, tidligere reproduktion og højere bestandstæthed på netoverdækkede arealer.

Populationsdynamik hos den afrikanske rotte *Mastomys* blev undersøgt på grundlag af data, som blev indsamlet i Tanzania og Ethiopien. En populationsmodel blev udviklet for at forudsige rotteudbrud og simulere bekæmpelsesmetoder.

Som led i eftersøgningen for det vilde **reservoir for Ebola virus** blev en stor samling af hvirveldyr fra Kikwit, Congo, analyseret.

Effektivitetsvurdering af bekæmpelsesmidler

Vurderingen af effektiviteten og anvendeligheden af de kemiske bekæmpelsesmidler, der anmeldes til godkendelse og klassificering hos Miljøstyrelsen, er en vigtig opgave for SSL. Resultatet danner grundlag for bedømmelsen af nye etiketter og brugsanvisninger.

I nogle tilfælde måtte der kræves mere dokumentation for effektiviteten eller ændring i anvendelsesområdet, før midlet kunne indstilles til godkendelse. I andre tilfælde kunne vi ikke gå ind for midlets anvendelse til det ønskede formål. Der tages ved denne vurdering hensyn til specielle danske forhold, f.eks. med hensyn til udvikling af resistens mod midlet eller mod beslægtede midler.

Andre oplysninger i årsberetningen

I afsnit 15 kan man finde de insekter og pattedyr, der holdes i kultur på Statens Skadedyrlaboratorium.

I afsnit 16 kan man finde medarbejdernes publikationer og forsøgsrapporter udarbejdet i 1997 og første halvdel af 1998.

I afsnit 18 findes en oversigt over de af Statens Skadedyrlaboratorium anerkendte bekæmpelsesmidler mod skadedyr.

1. Introduction

It is a pleasure for me to introduce the laboratory's 1997 Annual Report.

The laboratory's financial situation continues to be stable with a satisfactory distribution between our basic budget and our externally financed activities. The laboratory intends to maintain this combination, which gives an acceptable balance between strategic research and applied research.

The two projects on biological and microbiological pest control and the project on the biochemical mechanisms behind pesticide resistance are now running satisfactorily, and the first results are being published. The micro-biological and biological pest control programme is carried out in collabo-ration with the Royal Veterinary and Agricultural University and the Danish Institute of Plant and Soil Science. The resistance research programme involves the University of Roskilde and the Danish Institute of Plant and Soil Science. The training of Ph.D. students is incorporated in both programmes. Besides a Ph.D. project in progress concerning rodent biology and biological control in Denmark, a similar project was initiated in Tanzania, and we expect that another Ph.D. project concerning rodent resistance will begin next year. The laboratory gives training of young scientists high priority and we intend to attach Ph.D.-students to future projects when possible.

The high level of activities calls for more space. It is my hope that in the near future the laboratory can increase the working area by rebuilding or extending our facilities.

Finally, I should like to take this opportunity to thank the board and all staff members for their close co-operation.

N. Bille

2. Management and organization

2.1 Board of the Danish Pest Infestation Laboratory

Members:

Boy Overgaard Nielsen
University of Aarhus
Chairman

Bent Christensen
University of Copenhagen

Lars Damberg
Danish Pest Infestation Laboratory

Peter Esbjerg
Royal Veterinary and Agricultural University
Vice-chairman

Lise Stengård Hansen
Danish Pest Infestation Laboratory

Hans Kristensen
Danish Agricultural Advisory Centre

Leif Mortensen
Danish Environmental Protection Agency

Lars Diernæs
Research Secretariat, Danish Directorate for Development, Observer

2.2 Staff 1997

DIRECTOR
Nils Bille

SECRETARIAT, ACCOUNTS AND BOOKKEEPING
Inge Børgesen
Marianne Christensen (part-time) (from 10.11)
Lisbeth Gammelgaard (part-time)
Jette Hansen (part-time)
Ilse Hall Jensen
Kirsten Engell Jørgensen (part-time)
Hanne Olsen
Aase Rasmussen (part-time) (until 31.10)
Vibeke Rostgaard Schmidt
Annette Pilgaard

DEPARTMENT OF ENTOMOLOGY

Scientists
Jørgen Brøchner Jespersen (Head)
Charlotte Danielsen (until 31.07)
Lise Stengård Hansen* (part-time)
Karl-Martin Vagn Jensen*
Ole Østerlund Kilpinen
Michael Kristensen
Kim Søholt Larsen*
Mette Knorr Lauridsen (from 09.01 until 31.07)
Henri Mourier
Per Sejerø Nielsen
Alice Olsen (until 31.03)
Henrik Skovgård Pedersen
Anne Marie Rasmussen (until 31.05)
Ole Skovmand (until 31.10)
Andrew Spencer
Tove Steenberg

* Senior Research Scientists

Technicians

Aase Borges (part-time)
Ulrik Cold
Lars Damberg
Kristian Fordsmand (until 31.03)
Eva Hald
Henriette Hansen (from 01.03 until 31.10 and from 19.12)
Nicolai Hansen (from 15.12)
Gitte Jensen
Marianne Søs Ludvigsen
Bodil Malle Pedersen (part-time)
Kirsten Peschel
Jonna Rungsøe
Minna Wernegreen

MAMMAL DEPARTMENT

Scientists

Herwig Leirs (Head)
Jens Lodal

Technicians

Sarah Adams
Kristian Fordsmand (from 01.04)
Folmer Jensen

TECHNICAL MANAGEMENT

Jørgen Christensen

Assistants in the workshop

Githa Christensen (1)
Solveig Quist Nielsen (until 28.02 and from 21.07 until 31.10)
Ib Bjarne Nielsen (1) (from 17.11)

(1) Paid using special reemployment funds

2.3 Ph.D. and M.Sc. students

Michael Carlsen, Ph.D. student (University of Aarhus)
Vibeke Kalsbeek, Ph.D. student (Royal Veterinary and Agricultural University, Copenhagen)
Saskia Mercelis, Ph.D. student (from 01.10, University of Antwerp, Belgium)
Solveig Vibe-Petersen, Ph.D. student (from 01.11, Royal Veterinary and Agricultural University, Copenhagen)

Thomas Bolbroe, M. Sc. student (University of Copenhagen)
Lars Dag Erichsen, M.Sc. student (University of Copenhagen)
Mette Homann Keseler, M.Sc. student (University of Aarhus)
Thomas Nørgaard, M.Sc. student (University of Aarhus)
Tina Stendal Mortensen, M.Sc. student (University of Copenhagen)

2.4 Guest scientist

As in previous years we have had the pleasure of frequently seeing J. Keiding, Scientist Emeritus.

3. International collaboration

3.1 Conferences

J. B. Jespersen attended a Danida meeting on research in agriculture and aid to developing countries, 11 February, in Copenhagen, Denmark.

H. Leirs and J. B. Jespersen attended a Danida meeting on Danish Research in International Health, 21 February, in Copenhagen, Denmark.

K. S. Larsen participated in the Fourth International Symposium on Ectoparasites of Pets, 6-8 April, Riverside, California, USA.

A. Spencer, M. Kristensen, K.-M. V. Jensen and J. B. Jespersen participated in Resistance '97 Integrated approach to combating resistance, 14-16 April 1997, at IARC-Rothamsted, Harpenden, UK. J. B. Jespersen and M. K. Lauridsen presented a paper entitled "Management of insecticide resistance in the housefly *Musca domestica* using paint-on baits". M. Kristensen, A. Spencer, and J. B.Jespersen presented a poster entitled "Development and implementation of biochemical insecticide resistance detection in Danish field strains of *Musca domestica* ", and A. Spencer, M. Kristensen, and K.-M. V. Jensen presented a poster entitled "The biochemical detection of insecticide resistance in Danish field populations of the German cockroach *Blattella germanica* (Blattellidae)".

J. B. Jespersen attended the First ENMARIA workshop, 17-18 April, held at IACR Rothamsted, where he presented a working paper on pesticide resistance problems in Denmark.

O. Kilpinen participated in the XVIII Symposium of the Scandinavian Society for Parasitology, 22-24 May, in Rønne, Denmark.

N. Bille participated in the annual meeting of the Nordic Pesticide Registration authorities, 10-12 June, in Bergen, Norway.

Vibeke Kalsbeek participated in the 6th European Meeting in the IOBC/ wprs Working Group "Insect pathogens and insect parasitic nematodes" that was held in Copenhagen, August 10-15. She presented a paper entitled "Persistence of *Entomophthora schizophorae* Conidia on Different Surfaces at Different Temperatures".

T. Steenberg was part of the local organizing committee for the 6th European Meeting in the IOBC/wprs Working Group ‘Insect pathogens and insect parasitic nematodes’ that was held in Copenhagen, August 10-15. She presented a paper entitled “Microbial pest control in animal husbandry” and a poster entitled “Entomopathogenic fungi for control of German cockroach and other synanthropic cockroaches”.

L. S. Hansen participated in the meeting of the IOBC/WPRS study group on “Integrated protection of stored foodstuffs and other commodities” in Zürich, Schweiz, August 31 - September 2, 1997, where she presented a paper entitled “Prospects for developing strategies for biological control of the Mediterranean flour moth *Ephestia kuehniella* in flour mills”.

P. S. Nielsen participated in the meeting of the IOBC/WPRS study group on “Integrated protection of stored foodstuffs and other commodities” in Zürich, Schweiz, 31 August - 2 September, 1997, where he presented a paper entitled “*Blattisocius tarsalis* (Berlese), would this predatory mite be effective against moth eggs in Scandinavian flour mills?”.

H. Leirs and J. Lodal participated in the First European Vertebrate Pest Management Conference, 1-3 September at the Central Science Laboratory in York, UK. J. Lodal presented a paper entitled "The mole: A matter of control or conservation". H. Leirs chaired one of the sessions.

H. Leirs participated in the 7th International Theriological Congress, 7-11 September in Acapulco, Mexico, where he was Convenor of the symposium “Ecology of disease and parasites in small mammals: victims and models” and of the symposium “Biology and management of rodent pests”. He presented two papers: "Hunting Ebola virus in Kikwit: Lessons for mammalogists" and "Simulating and forecasting African *Mastomys* populations"

H. Leirs and J. B. Jespersen attended a Danida meeting with the Directors of the CGIAR institutes, 17-18 September, in Copenhagen, Denmark, to discuss potential future collaboration..

3.2 Visits and co-operation

DPIL staff paid visits to the following countries:

3 January, J. B. Jespersen visited IACR Rothamsted, UK, to discuss ENMARIA business matters.

16-17 January, T. Steenberg visited Dr. Judy Pell and Ph.D.-student V. Kalsbeek, Rothamsted Experimental Station, England, to discuss the progress of V. Kalsbeek's work.

28-30 January, H. Leirs visited the Department of Zoology, University of Oslo, Norway, to discuss population dynamics of *Mastomys* rats.

1-3 March, H. Leirs visited the Department of Biology, University of Antwerp, Belgium, to discuss joint projects and exchange of students.

2 April, K. S. Larsen visited Centers for Disease Control and Prevention, Plague Section, Fort Collins, Colorado, USA, to discuss plague control.

3-4 April, K. S. Larsen visited National Wildlife Reseach Center, Fort Collins, Colorado, USA, and gave a talk on "The plague situation in the Lushoto district, Tanzania".

21-23 May, K. S. Larsen visited Frank Clark, Department of Zoology, University of Leicester, England, to discuss flea research projects.

4-6 June, J. B. Jespersen visited the University of Oviedo, Spain, to plan field trials on semiochemicals.

9-12 July, K.-M. V. Jensen visited the Universidad de Oviedo, Spain, to participate in the design and initiation of the trials with semiochemicals. (AAIR proposal 1445).

6-9 August, J. B. Jespersen visited the University of Oviedo, Spain, to evaulate field trials on semiochemicals.

8 - 25 August, H. Leirs visited Indonesia, Malaysia, Vietnam, and Australia as member of a review team for the Australian Center for International Agricultural Research (ACIAR), reviewing research projects "Management

of rodent pests in Southeast Asia" and "Management of rodent pests in Vietnam".

4 September, H. Leirs and J. Lodal visited Dr Alan MacNicoll and Dr Roger Quy at the Central Science Laboratory, Sand Hutton, York for discussions on rodent control and anticoagulant resistance in rats.

23 September, J. B. Jespersen participated in an SEMG meeting in Brussels, Belgium.

29 September-16 October, M. Kristensen visited Martin Williamson, IARC-Rothamsted, Harpenden, England. They succeeded in developing a molecular diagnostic method for pyrethroid resistance caused by modification of the voltage dependent sodium channel protein in the housefly *Musca domestica*, in order to survey the mutation frequency of this mechanism in field populations.

13 October, M. Kristensen and K. S. Larsen visited Institute of Virology & Environmental Microbiology, Oxford, England.

13-14 October, J. B. Jespersen visited the Central Veterinary Institute, Lelystad, Holland.

3-5 November, J. B. Jespersen visited Rhone-Poulenc, Lyon, France.

3-5 December, J. B. Jespersen visited Almeria, Spain, to plan the second ENMARIA workshop.

15-16 December: H. Leirs visited the Department of Biology, University of Oslo, Norway, to discuss the progress of collaborative work on population dynamics of African field rats.

The DPIL was visited by the following colleagues and other guests:

2-4 March, G. Thomas (CVI, Lelystad, Holland), J. Trapman (CVI, Lelystad, Holland), H.J.Prijs (CVI, Lelystad, Holland) and L. Wadhams (IACR-Rothamsted, UK) participated in the 9th meeting on flies on grazing cattle and semiochemicals (AAIR proposal 1445).

18 March, Dr. Thomas S. Jensen and 12 students, University of Aarhus, Department of Zoology, to discuss various aspects of pest control.

23 April, Dr. Sigitas Lazauskas, Lithuanian Institute of Agriculture, and Dr. Peteris Busmanis, Latvia University, Latvia; general information.

15 May, Jan Theunissen, WHO Regional Office for Europe, and Norman Gratz, Geneva, to discuss body lice control and insect vectors in general.

24 June, Dr. Ian Denholm, IACR Rothamsted, UK, to discuss ENMARIA business matters.

15 July-15 November, Saskia Mercelis, University of Antwerp, visited the laboratory for four months in the framework of the European Union Leonardo vocational training program.

10 October, Dr. Garry Hill, International Institute of Biological Control, U.K., to discuss possibilities of future collaboration.

26-28 November, Thomas Brevig, M. Sc. student, University of Oslo, Norway, to discuss management simulations with a population dynamics model for African field rats.

28 November, Prof. Dr. Nils Chr. Stenseth, University of Oslo, to discuss population dynamics in African field rats.

Dr. Jan-Erik Bergh, Dalarna University College, Sweden, spent three periods of several days at the laboratory in March, May, and September to do research in a project on museum pests.

3.3 WHO Collaborating Centre and Expert Panel

The DPIL is a "WHO Collaborating Centre on Pesticide Resistance". The terms of reference are:

1. To study insecticide resistance developments in flies, cockroaches and rodents, and to establish discriminating concentrations/exposure times to different pesticides used for the control of these pests.

2. To maintain strains of susceptible and resistant colonies for the above studies and serve as a reference centre providing material from the above colonies for other WHO collaborators.

3. To study how to overcome resistance problems caused by the above-mentioned pests through delay approaches, alteration, change of control methods or a combination of methods.

Much of the work summarized in the section "Scientific and technical work" fulfils the terms of the centre. The DPIL is looking forward to a continued and extended collaboration with the WHO.

Since 1991 J. B. Jespersen has been a member of the WHO Expert Advisory Panel on Vector Biology and Control. In 1996 J. B. Jespersen accepted an invitation to serve as a member of the above-mentioned WHO Expert Panel for a further period of four years.

3.4 EPPO (European and Mediterranean Plant Protection Organization)

As from October 1994 J. Lodal has become a permanent member of the EPPO Rodent Control Panel.

3.5 Scientific and Environmental Monitoring Group (SEMG)

In 1985 the European Commission formed the SEMG to monitor the application of insecticide in the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) om Malawi, Mozambique, Zambia and Zimbabwe. In 1992 the mandate of SEMG expanded to include other effects of tsetse control with regard to land use and other possible environmental effects. In addition the activities of SEMG were not to be restricted to just RTTCP, but could now also involve all other EDF-funded projects in Africa. In 1997 the role and mandate of the SEMG were reviewed again. The mission of SEMG is now to support the European Commission, its member states and partners in the development and implementation of socially, economically and environmentally sustainable livestock production systems for agriculture.

At a meeting in Brussels on September 23-24, 1997, the new terms of references were discussed, agreed upon, and referred to the member states.

J. B. Jespersen has been the Danish member of SEMG since 1988.

3.6 Hypodermosis of livestock in Europe

As part of the European Co-operation in the field of Scientific and Technical Research, a European Concerted Action on improvements in the means of control of the warble fly in cattle and goats was established in 1991. Altogether, 13 countries are involved in implementation of the COST Action 811, which is organized by the Management Committee. In 1994 J. B. Jespersen was appointed the Danish representative of the Management Committee.

In 1991 COST action came to an end. The final report entitled: “Improvements in the control methods for warble fly in livestock”, COST 811, Agriculture, European Cooperation in the field of scientific and technical research, pp 141, 1998, edited by C. Boulard, J. Sol, K. Pithan, D. O’Brian, K. Webster and O. C. Sampimon, and published by the European Commission, Rue de la Loi 200, B-1049 Brussels, Belgium.

3.7 ENMARIA: European Network for the Management of Arthropod Resistance to Insecticides and Acaricides

ENMARIA (European Network for the Management of Arthropod Resistance to Insecticides and Acaricides), a new EU-funded Concerted Action, was launched in November 1996 to promote the development and implementation of management strategies for insecticide and acaricide resistance throughout Europe, thereby minimizing reliance on these chemicals and avoiding their increased use following resistance outbreaks. Nominated participants in ENMARIA include scientists and advisors from 12 countries and the agrochemical industry’s Insecticide Resistance Action Committee (IRAC). ENMARIA hopes to achieve progress in four main areas - compilation of a European resistance database, workshops, training visits and publicity.

This database will detail all individuals and institutions engaged in insecticide and acaricide resistance research activities, and all available information on the incidence, impact and management of resistance in EU and EFTA countries. It will also include information on insect strains (especially susceptible reference strains) cultured by different laboratories that could be shared to save unnecessary duplication of effort.

The workshops will aim to develop and promote standardized methods for detection and monitoring of resistance and to identify and disseminate guidelines for its management.

The first workshop was held at IACR-Rothamsted in April 1997, in conjunction with the Resistance '97 International Conference on Pesticide Resistance. In addition to reviewing scientific aspects of resistance, the workshop identified important constraints to implementing resistance management on a large scale - in particular the difficulties with ensuring sufficient cooperation between researchers, advisors and industrialists to formulate management guidelines and with disseminating recommendations to end-users. It was concluded that ENMARIA should focus its attention on pest problems or relevance to Europe as a whole, while still contending with issues of more local importance.

A second workshop will take place in Almería in southern Spain in May 1998. Difficulties encountered in this region with insect and mite control encapsulate well the need to integrate resistance management tactics with non-chemical approaches and are relevant to protected horticulture throughout Europe.

ENMARIA participants will be contributing to several influential meetings during 1998, including the 9th IUPAC Congress on Pesticide Chemistry (London), 50th International Symposium of Crop Protection (Ghent) and the Brighton Crop Protection Conference - Pests and Diseases, where insecticide and acaricide resistance (including the activities of ENMARIA) will receive much coverage and discussion.

ENMARIA will soon have a web site giving information about is activities. The home page will include logos, maps and details of participants, and the site will eventually include working papers prepared by national representatives reviewing resistance problems in their respective countries.

ENMARIA sponsors technical training visits, focusing on techniques for monitoring resistance and evaluating resistance. The first of these was undertaken in September 1997 by Dr Michael Kristensen of the Danish Pest Infestation Laboratory, who spent 3 weeks at IACR-Rothamsted acquiring expertise in the molecula diagnosis of target-site resistance to pyrethroids.

The primary long-term objective of ENMARIA is to encourage closer and formal scientific collaboration on resistance research between European laboratories, thereby avoiding duplication of effort and expertise. In addition, ENMARIA will remain committed to creating an environment more favourable for the implementation of resistance management strategies, notably by promoting open and frequent dialogue between researchers, pest management advisors, the agrochemical industry and regulatory authorities.

Involvement in ENMARIA is open to all interested individuals and organizations; further details are available from the main coordinators whose details are listed below:

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3.8 Field rat ecology in Tanzania

DPIL has taken up the coordination of long-time field studies in Morogoro, Tanzania, which attempt to better understand the population ecology of the important agricultural public health pest rodent *Mastomys natalensis*, and use this knowledge to design improved management strategies.

This work happens in close collaboration with the Rodent Research Unit of the Sokoine University of Agriculture and the Rodent Control Centre of the Ministry of Agriculture, both in Morogoro, the University of Antwerp, Belgium and the University of Oslo, Norway. Recent work has been funded by the European Union (DG XII- STD3 program), DANIDA, and the Belgian Agency for Development Cooperation.

Similar research is being undertaken, in collaboration with DPIL, at the Addis Ababa University, Ethiopia, and the Kenyatta University in Nairobi.

4. Educational activities

4.1 Training courses

In February nine one-day courses for personnel using phosphine-generating pellets for the control of moles and water voles were run by J. Lodal in various parts of the country. A total of 607 persons participated.

24 April, K. S. Larsen chaired a course on ectoparasites on cats and dogs held by the Industrial Assosiation of Veterinary Medicine and gave a talk on “Biology and control of fleas on cat and dog”.

13-14 May, a course on biology and control of insects, mites and rodents was run for military personnel intended to operate in foreign countries (N. Bille, K. S. Larsen, L. S. Hansen and J. B. Jespersen).

4.2 Lectures

21 January, J. Lodal gave a lecture on rat resistance to anticoagulants at an authorization course in rat control held by the Ministry of the Environment, Copenhagen.

22 January, N. Bille gave a lecture on “The Proper Use of Rodenticides. Risks and Hazards” at an authorization course in rat control held by the Ministry of the Environment, Copenhagen.

29 January, H. Leirs gave a seminar on population dynamics of *Mastomys natalensis* rats at the Department of Zoology, University of Oslo, Norway.

30 January, K.-M. V. Jensen: "Insects in food producing establishments", a lecture given as part of a course arranged by the Danish Society of Veterinarians.

20 February, J. B. Jespersen gave a lecture on biology and control of litter beetles at a training course for broiler farmers at Koldkærgaard, Aarhus.

2 March, H. Leirs gave a seminar on population dynamics of *Mastomys natalensis* rats, at the Department of Biology, University of Antwerp, Belgium.

10 March, L. S. Hansen gave two lectures on “Pests related to storage and production of food” for food technology students at the Royal Veterinary and Agricultural University, Copenhagen.

13 March, L. S. Hansen gave a lecture on “Stored product pests and pest allergens” at the Spring Meeting of the Danish Cereal Association.

18 April, L. S. Hansen gave a lecture on “Biology and control of seed destroying pests” for a group of students from developing countries participating in a course on seed pathology at the Danish Plant Directorate.

28 May, L. S. Hansen participated in a seminar for museum conservators on packing of museum objects (textiles, paper documents, books etc.) and presented the results of a project on insecticide treated packing materials.

21 August, H. Leirs presented a divisional seminar at CSIRO’s Division of Wildlife and Ecology, Canberra, Australia, entitled "Hunting Ebola in Kikwit & the multimammate rat in Morogoro."

18 September, K. S. Larsen: “Cat flea biology”, a lecture to the Veterinary Society on Funen.

10 December, J. Lodal gave a lecture on town pigeons and how to reduce damage caused by pigeons at a one-day seminar arranged by the Municipality of Copenhagen.

4.3 External examiner and reviewer duties

N. Bille served as an external examiner for veterinary students in veterinary special pathology and in environmental hygiene. He is also in charge as chairman of the external examiners at the Veterinary Faculty, Royal Veteri-nary and Agricultural University, Copenhagen.

N. Bille served as a referee for the *Belgian Journal of Zoology* (1).

L. S. Hansen served as an external supervisor for Ph.D. student Charlotte Danielsen, University of Copenhagen.

L. S. Hansen served as an external examiner for forestry students in forestry entomology and ecology at the Royal Veterinary and Agricultural University, Copenhagen.

J. B. Jespersen served as a supervisor for two M. Sc. students, University of Copenhagen , and for one Ph.D. student, Royal Veterinary and Agricultural University, Copenhagen.

K. S. Larsen served as a referee for the *Belgian Journal of Zoology* (2) and *Journal of Medical Entomology* (1).

H. Leirs served as a supervisor for two M.Sc. students at the University of Antwerp (Belgium).

H. Leirs served as an adviser to an M.Sc. student at the University of Oslo (Norway).

H. Leirs served as a member of the Editorial Board to *Mammalia* (Paris).

H. Leirs served as a referee for *Mammalia* (6), *Journal of Tropical Ecology* (2), *Wildlife Research* (1); as editor of a special issue for the *Belgian Journal of Zoology*, he reviewed 21 contributions.

H. Leirs served as a reviewer for the European Union (DG XII - ISTC program) and the International Foundation for Science.

J. Lodal served as a supervisor for one Ph.D. student, University of Aarhus.

J. Lodal served as a referee for the *Belgian Journal of Zoology* (1).

T. Steenberg served as a reviewer for *Journal of Invertebrate Pathology (1) and Sydowia (1)*.

5. Advisory work

5.1 Number of inquiries arranged by species

In 1997 the DPIL answered approximately 12,150 general inquiries from farmers, the food industry and other firms, veterinary surgeons, doctors and other health services, the news media, and private individuals with pest problems. Of these inquiries, 76% were telephone calls, 21% letters (often with animals enclosed for identification) and 3% visits to the laboratory. Many were answered by a leaflet on the subject, while others demanded special replies, sometimes after extensive studies.

In Table 5a, the inquiries are arranged by subject from a practical rather than a consistently zoological point of view. Many of the animal species or groups in the list do not deserve pest status. However, opinions vary and, for instance, in food articles any animal (or even trace of an animal) is often considered a problem. Every effort was also made to confirm that dubious animals were *not* pests.

Some of the inquiries led to inspections on location, but this type of frequently very time-consuming activity has been kept at a minimum since other engagements have priority. In 1997 there were 24 such inspections, paid for by insurance companies or other customers. Most of them concerned attacks of wood-boring insects in buildings.

As seen in Table 5a, the species which generated most inquiries were hornets (*Paravespula spp.*), the common black ant (*Lasius niger*), the mouse (*Muridae*), *Ctenocephalides* species (probably nearly all *Ct. felis)*, the common furniture beetle (*Anobium punctatum*), head lice (*Pediculus capitis*), a mortar-attacking bee (*Colletes daviesanus*) and the Indian meal moth (*Plodia interpunctella*). Together these eight subjects made up 39% of the total number of inquiries.

Table 5a. Number of inquiries in 1997

Leaflets (in Danish) are available on pests marked with an asterisk (*)

	Thysanura	**Børstehaler**	
*	*Lepisma saccharina*	Sølvkræ	144
*	*Thermobia domestica*	Ovnfisk	5
*	**Collembola**	**Springhaler**	15
	Orthoptera	**Retvinger**	
*	*Acheta domestica*	Husfårekylling	93
	Blattaria	**Kakerlakker**	
	Blatta orientalis	Orientalsk kakerlak	1
*	*Blattella germanica*	Tysk kakerlak	111
	Ectobius lapponica	Skovkakerlak	2
	Periplaneta americana	Amerikansk kakerlak	6
	Periplaneta australasiae	Australsk kakerlak	4
*	*Supella longipalpa*	Brunstribet kakerlak	10
	Blattaria div.	Kakerlakker div. ..	22
	Isoptera	**Termitter**	5
	Dermaptera	**Ørentviste**	
*	*Forficula auricularia*	Alm. ørentvist	67
*	**Copeognatha**	**Støvlus**	159
	Mallophaga	**Pelslus og fjerlus**	6
	Siphunculata	**Lus**	
*	*Pediculus capitis*	Hovedlus	469
	Pediculus corporis	Kropslus	2
*	*Phthirus pubis*	Fladlus	13
	Siphunculata div.	Lus div.	5

*	**Thysanoptera**	**Thrips**	34
	Hemiptera	**Næbmunde**	
	Anthocoris nemorum	Bladlustæge	3
*	*Cimex lectularius*	Væggelus	127
	Cimex pipistrelli	Flagermus-væggelus	1
	Gastrodes ferrugineus	Kogletæge	3
*	*Reduvius personatus*	Støvtæge	7
	Hemiptera div.	Tæger, bladlus, cikader div.	58
	Neuroptera	**Netvinger**	
*	*Chrysopa* spp.	Guldøjer	16
	Lepidoptera	**Sommerfugle**	
*	*Aphomia sociella*	Humlevoksmøl	70
*	*Caradrina clavipalpis*	Tagorm	2
*	*Endrosis sarcitrella*	Klistermøl	3
*	*Ephestia elutella*	Kakaomøl	1
*	*Ephestia kuehniella*	Melmøl	44
*	*Hofmannophila pseudospretella*	Alm. frømøl	38
	Nemapogon sp.	Kornmøl	1
*	*Plodia interpunctella*	Tofarvet frømøl	476
	Pterophoridae sp.	Fjermøl	1
*	*Tinea pellionella*	Pelsmøl	70
*	*Tineola bisselliella*	Klædemøl	208
*	*Lepidoptera* div.	Sommerfugle div.	83
	Coleoptera	**Biller**	
*	*Alphitobius diaperinus*	Lille melbille	3
	Amphimallon solstitiale	Sankthans-oldenborre	2
*	*Anobium punctatum*	Alm. borebille	610
*	*Anoplodera rubra*	Rød blomsterbuk	11
	Anthrenus museorum	Museumsklanner	1
*	*Anthrenus* spp.	Tæppebiller	339
*	*Attagenus pellio*	Alm. pelsklanner	42
*	*Attagenus smirnovi*	Brun pelsklanner	291
	Bostrychidae	Bostrychider	19
	Bruchidae	Bønnebiller	10
*	*Callidium violaceum*	Violbuk	21
*	*Carabidae*	Løbebiller	50
	Clytus arietis	Hvepsebuk	1
	Coccinellidae	Mariehøns	3

	Corynetes coeruleus	Skinkebille	1
*	*Criocephalus rusticus*	Brun træbuk	18
	Cryptolestes ferrugineus	Rustfarvet kornbille	1
*	*Cryptophagus* spp.	Skimmelbiller	13
*	*Dermestes haemorrhoidalis*	Husklanner	137
*	*Dermestes lardarius*	Flæskeklanner	75
	Dermestes maculatus		1
	Dinoderus minutus	Lille bambusborer	1
	Dysticidae spp.	Vandkalve	6
*	*Ernobius mollis*	Blød borebille	10
	Europhryum confine	Boresnudebille	1
*	*Hadrobregmus pertinax*	Rådborebille	38
*	*Hylesinus fraxini*	Askebarkbille	3
*	*Hylobius abietis*	Nåletræssnudebille	3
*	*Hylotrupes bajulus*	Husbuk	57
*	*Lasioderma serricorne*	Tobaksbille	40
*	*Lyctus* spp.	Splintvedbiller	11
	Meligethes spp.	Glimmerbøsser	4
	Melolontha melolontha	Alm. oldenborre	6
*	*Nacerdes melanura*	Bolværksbille	5
	Necrobia sp.	Koprabille	1
*	*Ocypus olens*	Stor rovbille	12
	Opilo domesticus	Hus-præstebille	1
	Oryctes nasicornis	Næsehornsbille	2
	Oryzaephilus mercator	Jordnøddebille	34
*	*Oryzaephilus surinamensis*	Savtakket kornbille	41
*	*Otiorhynchus sulcatus*	Væksthussnudebille	21
*	*Otiorhyncus* spp. .	Øresnudebille	36
	Phyllopertha horticola	Gåsebille	11
*	*Phymatodes testaceus*	Bøgebuk	56
*	*Pselactus spadix*	Alm. boresnudebille	6
	Ptinus fur	Alm. tyvbille	8
	Ptinus tectus	Australsk tyvbille	3
*	*Reesa vespulae*	Amerikansk klanner	4
	Scolytidae	Barkbiller	15
*	*Sitona lineatus*	Stribet bladrandbille	12
*	*Sitophilus granarius*	Kornsnudebille	14
*	*Sitophilus oryzae*	Rissnudebille	17
	Sitophilus zea-mais	Majssnudebille	1
	Staphyllinidae	Rovbiller	18
*	*Stegobium paniceum*	Brødbille	114
*	*Tenebrio molitor*	Melbille	39

	Tenebroides mauretanicus	Korngnaver	1
	Tetropium castaneum	Sort granbuk	1
	Thylodrias contractus	Larveklanner	1
	Tribolium castaneum	Kastaniebrun rismelbille	6
*	*Tribolium confusum*	Rismelbille	29
*	*Tribolium destructor*	Lysolbille	5
	Trogoderma angustum	Smal frøklanner	11
*	*Xestobium rufovillosum*	Egens borebille	7
	Coleoptera div.	Biller div.	92
	Hymenoptera	**Årevinger**	
	Andrena spp.	Jordbier	69
	Apis mellifica	Honningbi	51
	Bombus spp.	Humlebier	154
*	*Camponotus* spp.	Herculesmyrer	67
*	*Colletes daviesanus*	Murbi	462
	Formica rufa	Rød skovmyre	40
	Formica spp.	Formica-myrer	56
	Lasius fuliginosus	Orangemyre	38
*	*Lasius niger*	Sort havemyre	761
*	*Lasius umbratus and others.*	Gule myrer	45
	Megachile spp.	Bladskærebier	2
*	*Monomorium pharaonis*	Faraomyre	29
	Osmia spp.	Murerbier	6
*	*Paravespula* spp.	Gedehamse	944
*	*Siricidae* spp.	Træhvepse	19
	Sphecoidae spp.	Gravehvepse	27
	Tapinoma spp.	Tropisk myreslægt	2
*	*Vespa crabro*	Stor gedehams	62
	Hymenoptera div.	Årevinger div.	48
	Diptera	**Tovinger**	
	Borboridae	Springfluer	15
*	*Calliphoridae*	Spyfluer	87
*	*Ceratopogonidae*	Mitter	11
	Chironomidae	Dansemyg	7
*	*Crataerina pallida*	Mursejlerluseflue	1
	Culicidae spp.	Stikmyg	49
*	*Drosophila* spp.	Bananfluer	96
	Eristalis spp.	Dyndfluer	1
	Fannia canicularis	Lille stueflue	60
	Lipoptena cervi	Hjortens luseflue	2

	Melophagus ovinus	Fårets luseflue	2
*	*Musca domestica*	Stueflue	88
*	*Mycetophilidae*	Svampemyg	46
	Phoridae	Pukkelfluer	5
*	*Pollenia* spp.	Klyngefluer	49
*	*Psychodidae*	Sommerfuglemyg	49
	Simuliidae spp.	Kvægmyg	5
	Stehepteryx hiriundinis	Svaleluseflue	1
	Stomoxys calcitrans	Stikflue	4
	Syrphidae spp.	Svirrefluer	15
*	*Tabanidae* spp.	Klæger	12
*	*Thaumatomyia notata*	Græsflue	6
	Tipulidae spp.	Stankelben	3
	Diptera div.	Tovinger div.	76
	Siphonaptera	**Lopper**	
	Archaeopsyllus erinacei	Pindsvineloppe	4
	Ceratophyllus spp.	Fuglelopper	135
*	*Ctenocephalides* spp.	Katte- og hundelopper	546
	Ceratophyllus (Monopsyllus) sciurorum sciurorum	Egernloppe	1
*	*Pulex irritans*	Menneskeloppe	4
	Siphonaptera div.	Lopper div.	35
	Pests on textiles	Tekstilskadedyr	95
	Pests in food	Kolonialskadedyr	34
	Pests in wood	Træskadedyr	30
	Various insects	**Diverse insekter**	58
	Acarina	**Mider**	
*	*Acarus siro*	Melmide	30
*	*Argas reflexus*	Duemide	2
*	*Bryobia praetiosa*	Brunmide	47
*	*Cheyletiella* spp.	Pelsmider	15
*	*Dermanyssus* spp.	Fuglemider	20
*	*Dermatophagoides* spp.	Husstøvmider	13
	Gamasidae	Gamasider	2
*	*Glycyphagus domesticus*	Husmide	5
*	*Ixodes ricinus*	Skovflåt	109
	Neotrombicula autumnalis	Augustmide	1
	Oribatidae spp.	Pansermider	1

*	*Rhipicephalus sanguineus*	Husflåt	6
*	*Sarcoptes scabiei*	Fnatmide	13
*	Mites in grain, straw and hay	Lagermider	4
	Acarina div.	Mider div.	24
*	**Araneae**	**Edderkopper**	51
	Scorpiones	**Skorpioner**	1
*	**Pseudoscorpiones**	**Mosskorpioner**	2
*	**Diplopoda**	**Ægte tusindben**	20
	Chilopoda	**Skolopendre**	
*	*Geophilus carpophagus*	Jordskolopender	11
	Chilopoda div.	Skolopendre div.	11
*	**Oniscoidea**	**Bænkebidere**	38
	Oligochaeta	**Sadelbørsteorme**	
	Lumbricidae	Regnorme	13
	Nematoda	**Rundorme**	5
	Gastropoda	**Snegle**	
*	*Limacidae*	Kældersnegle	18
	Gastropoda div.	Snegle div.	32
	Amphibia	**Padder**	2
	Lamellibranchiata	**Muslinger**	
	Teredo navalis	Pæleorm	2
	Reptilia	**Krybdyr**	3
	Aves	**Fugle**	
*	*Columba livia domestica*	Tamdue	155
	Corvidae spp.	Kragefugle	2
	Pica pica	Husskade	4
	Aves div.	Fugle div.	8
	Mammalia	**Pattedyr**	
	Apodermus flavicollis	Halsbåndmus	30

*	*Arvicola terrestris*	Mosegris	309
	Chiroptera spp.	Flagermus	7
	Felis domestica	Huskat	5
*	*Martes foina*	Husmår	281
	Meles meles	Grævling	1
*	*Muridae*	Mus	425
*	*Rattus norvegicus*	Brun rotte	194
	Rattus rattus	Husrotte	3
	Sciurus vulgaris	Egern	1
*	*Talpa europaea*	Muldvarp	320
	Vulpes vulpes	Ræv	22
	Mammalia div.	Pattedyr div.	21

Various animals	**Diverse dyr**	90
Imaginary animals	**Indbildte dyr**	24
Pesticides	**Bekæmpelsesmidler**	135
Various	**Diverse**	266

5.2 Some of the cases and characteristic variations in the number of inquiries in 1997

Mosquitoes, *Culicidae*, were recorded in normal figures. Early in the season we believed that the occurrence of mosquitoes in 1997 would be low, due to a small amount of rain during January, February, and March. Heavy rain during May filled many of their breeding areas and brought the situa-tion back to normal.

German cockroach, *Blattella germanica*, has been recorded in low figures during the past three years. This year we received 111 inquires about this species, which is normal. The development of cock-roaches has probably been favoured by the very high temperatures recorded in July and August.

A supposed pest problem was recorded in August in reed imported from Turkey. The thatchers who handle the reed developed dermatitis. A similar case was recorded in 1996, where the residents in a house with a newly thatched roof experienced the same problems. In both cases we could not detect any pests causing dermatitis.

Arion lusitanicus, a snail, was seen on few locations in great numbers and was presented on national television. This resulted in a lot of inquiries from worried people, who believed that this snail was in their garden, where it can be a serious pest. Without attracting attention, this snail has formerly been recorded from several localities in Denmark, so it is probably quite unusual that it occurs in such high numbers.

Indian meal moth, *Plodia interpunctella*, was this year recorded in the highest figures ever. This species constituted nearly 40% of the inquiries that concerned pests in food. Calls concerning Indian meal moth have been increasing for a number of years. In most cases, the inquiries were made by private individuals who found larvae or adults in connection with products containing nuts, almonds or dried fruit. An explanation could be that the consumption of products containing food, in which these moths develop, has been increasing also. Last summer's unusual heat might also explain the very high number of calls.

Headlice, *Pediculus capitis,* occurred at the same high level as last year. Calls about headlice were previously especially frequent in periods after long school holidays. However, this seems not to be the case any more, as the inquiries are more evenly spread throughout the year. Chemists, health visitors, nursery teachers and parents are telling about an increasing amount of children suffering from headlice several times each year. Often they call because they suspect the pesticides used against headlice to be ineffective. In Denmark no research has been carried out that could enlighten the question about the increasing problems with headlice. Instructions about the correct way of using the pesticides against headlice and information about the biology of headlice and possible source of infection are important in the control of this species.

Giant hornet, *Vespa crabro,* has not since 1993 been recorded in such a high number as was the case this year. The amount of calls concerning hornets (*Paravespula spp*.) was not higher than usual in 1997.

Cat fleas, *Ctenocephalides felis,* have, for the last two years, been recorded in a lower number than the previous years. This might be the result of an increasing use of preventive formulations for control of fleas, since a new product came on the market in 1995.

A.-M. Rasmussen and P. S. Nielsen

Scientific and technical work

6. Flies

6.1 Chemical control of *Musca domestica*

6.1.1 Efficacy of CGA-X against susceptible and resistance strains of houseflies

The effect of feeding adult male houseflies with CGA-X was bioassayed in laboratory tests with several laboratory strains of *Musca domestica*, i.e. a susceptible reference strain WHO-SRS and eight strains with different patterns and levels of resistance to organochlorines, organophosphorus (OP) compounds, carbamates and pyrethroids.

The CGA-X tolerance in the strains was measured in feeding tests by feeding of granular sugar impregnated with a range of doses of CGA-X to adult male flies. The effect was determined by observance of the mortality of the flies after 24 hours and after 48 or 72 hours. The lethal concentrations (LC-values) were estimated by probit analysis.

Topical application tests and a few feeding tests were made to measure the resistance of the fly strains to various conventional adulticides against which the respective resistance mechanisms of the various resistant strains are directed. The results of these tests confirmed that the resistance level was moderate-to-high or high: in strain A_2bb against pyrethroids, in strain 17e against lindane, in strain 381zb against dimethoate and permethrin, in strain 690ab against methomyl, in strain 698ab against DDT and in strain 594vb against azamethiphos.

The results of the feeding tests with CGA-X indicated a cross-resistance between some of the conventional insecticides and CGA-X as the two strains 381zb and 690ab were clearly more resistant to CGA-X than the susceptible reference strain. In strain 381zb, which is both resistant to OP-compounds and to pyrethroids, it is most likely the resistance mechanisms against dimethoate which are responsible for the relatively high cross-resistance to the feeding effect of CGA-X. In strain 690ab the resistance against methomyl is responsible for the low-moderate cross-resistance to the feeding effect of CGA-X.

M. K. Lauridsen and J. B. Jespersen

6.1.2 Efficacy of two Fiproles against susceptible and resistant strains of houseflies

The insecticidal effect of two Fiproles was bioassayed in laboratory tests with various laboratory strains of *Musca domestica*, i.e. a susceptible reference strain WHO-SRS and four strains with different patterns and levels of resistance to organochlorines, organophosphorus compounds, carbamates and pyrethroids.

Topical application and feeding tests were made to measure the resistance of the four fly strains to various conventional adulticides against which the respective resistance mechanisms of the various resistant strains are directed. The results of these tests confirmed that the resistance level was moderate-to-high or high: in strain 17e against lindane, in strain 381zb against dimethoate and permethrin, in strain 690ab against methomyl and in strain 698ab against DDT.

The fiprole tolerance in the strains was measured in feeding and topical application tests with a range of doses of fiprole I and II to adult male and female flies, respectively. The effect was determined by observance of the mortality of the flies after 24 hours and after 48 and/or 72 hours. The lethal concentrations (dosages) were estimated by probit analysis.

The results of the feeding and topical application tests showed possible crossresistance between some of the conventional insecticides and the fiproles as some of the fly strains were clearly resistant to fiprole I and II when compared to the susceptible reference strain. The fiprole resistance is most likely caused by a reduced sensitivity of the GABA receptors, but this has to be confirmed. However, enhanced metabolism and penetration resistance may add to the effect, and other resistance mechanisms cannot be ruled out as resistance mechanisms involved.

J. B. Jespersen and M. K. Lauridsen

6.2 Insecticide resistance in *Musca domestica*

6.2.1 Resistance tests in fly populations on Danish farms

To improve the use of existing insecticides and delay the onset of resistance and treatment failures, it is important with regular surveys to establish the real extent of insecticide resistance, even for species with an extensive resistance history. Regular surveys of resistance to insecticides of interest in relation to housefly control in Denmark have been carried out for many years at DPIL by collection of houseflies on farms in various parts of the country and by tests of resistance in the offspring.

Aerosols or space sprays with either pyrethrum or bioresmethrin both synergized with piperonyl butoxide commonly used for housefly control are still effective on most farms in Denmark, but give only temporary control. Residual synthetic pyrethroids are not allowed for housefly control on farms in Denmark. More widely used are persistent insecticide treatments, which are performed by paint-on baits with organophosphates, mainly azamethiphos, but also propethamphos, or stick-on baits with the carbamate methomyl. Residual sprays with dimethoate and propethamphos are still registered for housefly control in Denmark. Larvicides containing the insect development inhibibitors diflubenzuron or cyromazine were effective, where breeding places could be treated properly, and larvicide usage is increasing.

Samples of 21 *Musca domestica* field populations were collected from animal houses in Denmark in 1997. We determined the susceptibility of the first generation offspring to different types of insecticides: the pyrethroids bioresmethrin and pyrethrin both synergized with piperonyl butoxide; the organophosphates dimethoate, azamethiphos and propethamphos; the carbamate methomyl and the two insect growth regulators diflubenzuron and cyromazine. The results showed that pyrethroid resistance is increasing in Denmark. On 4 of the 21 farms more than a 100-fold resistance was observed. Resistance to azamethiphos was widespread and high and has increased since the 1980s. Four strains is hypothesized to have an inherited behavioural phenotype contributing to the azamethiphos resistance observed. Status of dimethoate resistance showed a trend of populations with either increasing susceptibility or populations with increasing resistance. Two strains with high methomyl and propetamphos resistance were observed. Methomyl and propetamphos resistance is not increasing.
Resistance risk assesment of larvicides has been performed from their introduction in the early 1980s without finding strong indications of resistance development. In the 1997 survey we found beginning develop-

ment of resistance towards the benzophenylurea diflubenzuron, which to some extent has been observed earlier, and for the first time we found field strains with increased tolerance to cyromazine.

M. Kristensen and J. B. Jespersen

6.2.2 Resistance mechanisms of Danish houseflies

The 21 populations of *M. domestica* collected in 1997 for resistance assessment were analysed *in vitro* for biochemical characteristics commonly associated with insecticide resistance. Sixty-two females from each strain were assessed for activity towards the glutathione *S*-transferase substrates 3,4-dichloronitrobenzene (DCNB) and 1-chloro-2,4-dinitrobenzene CDNB), the general esterase substrate ρ-nitrophenyl buterate (ρNPB) and the P450 dependant monooxygenase substrate ρ-nitroanisol (ρNA). Specific activity towards the AChE substrate ATCI was measured in 63 females from each strain. The effect of three inhibitors, azamethiphos, methomyl and ome-thoate was also measured on each fly tested. The results gained show a significant elevation in enzyme activity in many of the populations - particularly those showing high levels of resistance. It can also be concluded that the majority of flies from most of the populations maintains enzyme activities consistent with susceptibility. Insensitivity to methomyl and omethoate is widespread but of low frequency. Azamethiphos insensitivity, however, is rare.

We have together with Martin Williamson, IARC-Rothamsted, developed and implemented a molecular diagnostic method for detecting pyrethroid resistance caused by modification of the voltage dependent sodium channel protein in the housefly, in order to survey the mutation frequency of this mechanism in field populations. The method enables us to determine the genotype of individual flies. The method is simple, reproducible and applicable for determining genotype frequencies in laboratory-reared or field-collected populations.

M. Kristensen and A. Spencer

6.2.3 Laboratory strains kept in 1997

At the end of 1997, the DPIL kept 22 strains representing a wide variety of resistance mechanisms and origins for use in testing and research work. A list of the strains and their origins is given in Table 6a. In all these strains, the resistance originated in the field. In several strains, selection with one (or two) insecticide(s) is carried out between one and four times a year in order to maintain the particular resistance.

As has been the case since the beginning of our investigation of resistance in houseflies in 1948, all our strains are available to laboratories that wish to use them for research, development of new insecticides, etc. This has assisted international research on insecticide resistance and given us useful feedback on our resistance problems.

J. B. Jespersen

Table 6a. Laboratory strains of *Musca domestica* maintained during 1997

	Strain	Origin	Year	Remarks	Lab pressure
1.	*Strains subjected to periodic insecticidal pressure (adult dipping, exposure to vapour, or with feeding treated sugar) from a compound to which at least part of the population showed clear resistance at the time of collection*				
	17 bb	DK	1950	Also some R to dieldrin and pyrethroids	DDT
	17 e	DK	1950	Some R to OPs	lindane
	150 b	DK	1955		diazinon*
	39 m_2b	DK	1969	DDT-R due to oxidation (mfo)	tetra-chlorvinphos*
	49r_2b	DK	1970		dimethoate*
	381 zb	DK	1978		permethrin 1979+ and dimethoate 1983+*
	690 ab	DK	1984	OP-R. Moderate R to methomyl	methomyl feeding*
	594 vb	DK	1988		azamethiphos*
	213 ab	S	1957	Py-R, Low OP-R. Collected near Stockholm	pyrethrins/ pbo*
	571 ab	J	1980	Collected on Tokyo's city dump (by K.Yasutomi). Very high OP-R, susceptible to pyrethroids	fenitrothion
	698 ab	Burma	1985	Collected at a market in Rangoon. R to DDT (no kdr), dieldrin, and malathion. Low-moderate R to other OPs	DDT

* Some resistance to various (other) OP compounds and to DDT

Table 6a. continued

	Strain	Origin	Year	Remarks	Lab pressure
2.	*Originally resistant field strains kept without insecticidal pressure*				
	7	DK	1948	Heterogeneous R to dieldrin. DDT-R reverted	None
	772 a	DK	1989	Moderate R to OPs and pyrethroids. Common laboratory test strain	None
3.	*Susceptible strains*				
	BPM	Leiden	1955		None
	WHO Ij_2	Pavia	1988, 1996		None
	RAC	Wage- ningen	1982	Chr. 1, 2 and 3 with marker genes	None
	NAIDM	Texas	1991		None
4.	*Strains with R mechanisms isolated*				
	A_2bb	DK	1982	Origin: Danish strain 381 z (1978) Chr. 3 with super-kdr isolated by Oppenoorth. Chr. 1, 2 and 3 with marker genes	None
	LPR	USA	1995	Received from J. Scott (Cornell University) R to pyrethroids	None
	Rutgers	USA	1995	Received from R. Feyereisen (University of Arizona) R to diazinon	None

6.3 Biological control of *Musca domestica* and *Stomoxys calcitrans*

6.3.1 Parasitic wasps

The house fly, *Musca domestica* L and the stable fly, *Stomoxys calcitrans* L are important pests in today's poultry, dairy cattle and pig production. The flies are a nuisance to animals as well as to humans and are potential vectors of pathogens. In traditional farming systems houseflies are controlled by means of an array of chemicals. This intensive control practice has led to widespread resistance to many of the chemicals used. Therefore, exploration for alternative or supplementary methods for fly regulation is needed. A promising method is biological control, where natural enemies are released into the pest habitat to bring down the pest population below injury or annoyance level.

One of the first steps in a biological control project should be a determination of the native enemy complex that interacts with the pest population. Thus, a nation-wide survey has been conducted in the period August to October, 1996 and 1997, where 84 pig and cattle farms were visited. Fly puparia were gathered on each farm to obtain information on activity and species composition of pupal parasitoids (*Hymenoptera: Pteromalidae*). In the survey there were registered ten species of pupal parasitoids being seven more than recorded in a previous study made about 30 years ago. The pre-dominant species in the survey were *Spalangia cameroni* Perkins and *Muscidifurax raptor* Girault & Sanders, respectively. A total of 69,880 puparia were collected, of which 12.9% of the puparia per farm were killed by the parasitoids indicating a relatively low activity by the parasites on Danish farms.

Parallel with the survey, the seasonal activity of the parasitoids has been studied on five farms scattered all over northern Sealand. Every second week starting in April and ending in December, sentinel bags with laboratory-reared *M. domestica* puparia were laid out in stables and dung heaps as "bait" for the wasps. After one week of exposure the puparia were collected and incubated for two months in the laboratory for the parasitoids to emerge. The species of parasitoids and their activity presented as percentage-parasitised puparia were then determined. Consistent with the above survey the predominant species of parasitoids were *Spalangia cameroni* and *Muscidifurax raptor*. Parasitoids that appeared in low numbers were *Spalangia nigra*, *Spalangia nigripes, Nasonia vitripennis*, *Urolepis rufipes*, and *Phygaedeon fumator*. The first records of parasitoids took place in May with a gradual increase in numbers and parasitism up to August which coincided with high ambient temperatures and peak abundance of flies.

Based on the survey and seasonal study it can be concluded: (*i*) the guild of pupal parasitoids was relatively large attacking both stable and housefly puparia at confined livestocks in Denmark; (*ii*) the two dominating species on most farms in the country were *S. cameroni* and *M. raptor*; (*iii*) the native parasitoids combined attacked only a small fraction of the fly puparia available, but on a few farms the parasitation reached 69% of the total puparia collected.

The studies above were the first step in a five-year-project partially funded by the Ministry of Food, Agriculture and Fisheries, with the aim of studying prospects of using parasitic wasps as control organisms against stable and houseflies in connection with confined animals in Denmark.

H. S. Pedersen and J. B. Jespersen

6.3.2 *Entomophthora muscae*

This study was conducted as part of a Ph.D. project. Previous studies have shown that although very high infection levels of the entomopathogenic fungus *Entomophthora muscae* have been observed during the summer, the fungus seems to have no obvious effect on the high number of houseflies in stables this time of year. The scope of this study was thus to evaluate the effect of the type of stable and time of year on the prevalence of *E. muscae.*

A survey was conducted including 33 farms with cattle and/or pigs (16, 9 and 8 farms with cattle, pig and both, respectively). Ten farms were visited in August, 10 in September, and 13 farms in October. On pig farms, it was noted if the unit used for fly collection was a farrowing unit. The use of heating lamps providing resting surfaces with temperatures higher than 40^{o}C in these units might give the flies the opportunity to make “behavioural fever” and thus cure themselves from the disease. Houseflies were collected in various locations inside the barns with a sweep net. On the day of collection the flies were anaesthetized with CO_2 and sorted in species and sex, 50 males and 50 females from each stable were placed individually in 22 ml plastic cups. The houseflies were examined daily for 10 days for patent *E. muscae* infection.

The prevalence increased significantly from August until October and a significantly lower proportion of houseflies was infected on the pig farms.

These results indicate that “behavioural fever” may be carried out by houseflies in stables with heating lamps.

V. Kalsbeek, J. B. Jespersen and T. Steenberg

7. Flies on pastured cattle

7.1 Manipulation of fly-load on heifers

The purpose of the field trials was to evaluate the efficacy of potential fly-repellants and attractants released from a tube dispenser attached to the cattle. The following fly species *Hydrotaea irritans, Haematobia irritans, Haematobosca stimulans, Musca autumnalis* and *Haematopota pluvialis* were recorded when present on the heifers. In the following a summary of the results obtained with *Ha. irritans* is presented.

Six different chemicals were delivered by IACR-Rothamsted, ready for use and applied to sponges in sachets. To slow down evaporation, the sachets were kept in the freezer when not in use. To protect the sachet and to protect the animals from the chemical, the sachet was placed in a dispenser, which was fixed to a leather belt. When a test was conducted, the belt was fixed around the chest of the heifer right behind the front legs. The dispenser was made of stainless steel and aluminium.

For the testing of one semiochemical, one herd was used. The heifers used were selected in a herd of approximately 40 heads, based on the heifers' ability to attract flies. Two small herds (7 heads each) were then gathered in such a way that both fly-attractive and fly-repellent heifers were used. Based on the fly-count data from day 0, the cattle were ranked with respect to fly-load.

On day one the dispensers on the two least fly-attractive cattle were loaded with a sachet containing the chemical. The flies on each heifer were identified and counted 6 times during the day. On day two the dispenser on the two most fly-attractive heifers was loaded with a sachet containing the same chemical. During the day, flies were counted as on day 1. As we had two herds at our disposal we could run two tests at the same time, using different chemicals.

With two of the chemicals there seemed to be some repellence towards the flies. When the least fly-attractive heifers were treated, they seemed to lose even the few flies they had had before the treatment. When the most fly-attractive heifers were treated the number of flies went down, and the number of flies on the least fly-attractive heifers went up. The same applied when three sachets were used per heifer, although it was even less clear as with the tests with only one sachet. With caution, based on these data, it can be argued that these two chemicals used on the most fly-attractive heifers in the herd redistributed the flies, so that the differences in fly-load between the different heifers were reduced. A more detailed study of the data will be needed to confirm this.

K.-M. V. Jensen and J. B. Jespersen

7.2 Microbial control of flies on pastured cattle

The aim of this project is to gain information of entomopathogenic fungi as potential candidates for microbial control of horn flies (*Haematobia irritans*), face flies (*Musca autumnalis*), and other fly species on pastured cattle. This includes a survey of naturally occurring fungal pathogens in these fly populations. In the time period from July to September live flies were collected every 14 days from six locations with pastured cattle. After 7 days of incubation in cardboard cages supplied with bovine blood, water and dried milk powder, dead flies were examined for signs of fungal infection.

The hyphomycetes *Beauveria bassiana* and *Verticillium lecanii* were isolated from a few flies from each location. These fungi did not appear to be a major mortality factor for adult flies, however. Similarly, no flies were infected by fungi from *Entomophthorales*. This is surprising, because there appears to be several good opportunities for disease transmission from other flies that are frequently infected by fungi from the '*E. muscae'* complex: in five locations houseflies (*Musca domestica*) in nearby stables were infected by the fungus. Horn flies can frequently be seen entering the stables with the cattle, and although they leave again quickly, there is a possibility of inoculum transfer during their stay there. Also infected houseflies were collected from hedgerows and from heifers pastured near a dung hill. In one location, different flies including sweat flies were observed resting on thistles with vast numbers of fungus-infected flies, but none of the horn flies and sweat flies collected from this location died from *E. muscae*. On a few occasions biting flies and face flies infected with *E.schizophorae* (4-6 nuclei) or *E. muscae* (15-23 nuclei) were found in additional surveys. This em-phazises that despite the negative results from the main survey, these flies can be infected with '*E. muscae'* in the field. The survey is to be continued in 1998.
Preliminary infection experiments with adult horn flies and face flies showed that both species are readily infected by fungi such as *Beauveria bassiana, Paecilomyces fumosoroseus* and others.

8. Cockroaches

8.1 Resistance in Danish field populations

An investigation of insecticide resistance in *B. germanica* was undertaken involving four field strains, a laboratory susceptible strain and a laboratory resistant strain. All strains were bioassayed against insecticides commonly used in cockroach field control and assayed *in vitro* for enzyme systems commonly associated with resistance.

In Table 8a the different strains are arranged in each row in order of magnitude. It is clearly demonstrated that there is a nearly perfect correlation between chlorpyrifos resistance and general esterase activity. This is shown not only by the mean activities, but also by the Duncan groupings. It is therefore likely that esterases play a significant role in the resistance detected.

On the other hand, there appears to be no such correlation in respect to AChE activity; although, as mentioned, insensitivity may play a role in resistance in strains C and D. Based on the data collected, there appears to be no correlation between pyrethroid resistance and the activities measured. Although resistance to pyrethroids remains high in Danish *B. germanica*, it is of far less significance than resistance to chlorpyrifos, since chlorpyrifos has for many years remained Denmark's only guarantee against control failure. The existence of individuals with high esterase activity and/or AChE insensitivity in field populations showing a degree of resistance is cause for concern and worthy of further investigation. It is our intention to collect cockroaches from a greater number of sites in future and to look in greater depth at the mechanisms responsible for any resistance detected. We also intend to confirm the apparent close link between esterase activity and chlorpyrifos resistance, and to establish which mechanism or combination of mechanisms is responsible for the high pyrethroid resistance.

This work is detailed in: Spencer A. G., Kristensen M. & Vagn Jensen K.-M. (1998) The biochemical detection of insecticide resistance in Danish field populations of the German cockroach *Blattella germanica* (Blattellidae). *Pesticide Science* 52, 196-198.

Table 8a.
Insecticide resistance and biochemical properties in field and laboratory strains of *Blattella germanica*. Each strain is represented by different letter and the strains arranged in order of magnitude for each of the properties shown (i.e. the strain at the left of each row is that with the highest insecticide resistance enzyme activity or insensitivity to AChE inhibition, while the strain to the right is that with the lowest). Duncan groupings, determined by SAS, are shown in superscript and distinguish significant difference between population means. Strains which share a Duncan group are not significantly different at population mean. This table shows clearly the correlation between chlorpyrifos resistance and esterase activity.

	Highest					**Lowest**
R/S LD_{50}						
Permethrin	C	D	E	B	A	S
Chlorpyrifos	A	B	C	D	E	S
Mean GST Activity						
CDNB	C^{a}	B^{ab}	A^{ab}	D^{bc}	E^{c}	S^{d}
DCNB	C^{a}	B^{a}	E^{a}	D^{b}	A^{c}	S^{d}
Mean Esterase Activity						
αNA	A^{a}	B^{a}	C^{a}	D^{ab}	E^{b}	S^{b}
βNA	B^{a}	A^{ab}	C^{bc}	D^{bc}	E^{c}	S^{d}
ρNPB	B^{a}	A^{a}	C^{ab}	D^{bc}	E^{c}	S^{d}
Mean AChE Insensitivity						
Methomyl	C^{a}	A^{ab}	D^{b}	E^{c}	S^{cd}	B^{d}
Azamethiphos	D^{a}	C^{ab}	B^{b}	S^{c}	E^{c}	A^{c}

A. Spencer and K.-M. V. Jensen

8.2 Entomopathogenic fungi for control of *Blatella germanica*

This project was initiated in 1996 and will end in 1998. An initial survey showed that entomopathogenic fungi could be isolated from field-collected German cockroaches along with other entomopathogenic organisms, although the prevalence was low. Most isolates of a range of entomo-pathogenic hyphomycetes proved to be infective to cockroaches, and based on low lethal time estimates two isolates were selected for further studies.

The relative pathogenicity of the fungi *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* was compared in bioassays, where insects were immersed briefly in aqueous spore suspensions and incubated separately in plastic vials with access to water and food. *M. anisopliae* was the most pathogenic species even though it was originally isolated from a heterologous host in contrast to the strain of *P. fumosoroseus* that originated from a German cockroach. For both fungi females proved to be more susceptible than males to fungal infection. Further tests including more strains of each fungus will show whether this is common for the two species of fungi. Likewise, the spore production capacity of *P. fumosoroseus,* which seems to be much higher than that of *M. anisopliae,* is also investigated for several strains. Further experiments will focus on the spread of the fungus disease in cockroach populations and on the possibility of applying the fungus as a bait.

T. Steenberg and K.-M. V. Jensen

9. Fleas

9.1 The squirrel flea *Ceratophyllus sciurorum sciurorum*

9.1.1 Circadian rhythms

The behavioural studies carried out in collaboration with the University of Leicester (Dr. Frank Clark, Dr. Derek Deadman and Stephen Pudney) and the University of Loughborough (Dr. Malcolm T. Greenwood) continued in 1997. We have looked at the effects of feeding on the circadian rhythms in the squirrel flea *Ceratophyllus sciurorum sciurorum*. Carcadian rythm in newly emerged fed individuals of this flea species was studied in a constant environment, using an insect activity monitor. The results of the trials run continuously over 7 days confirmed the finding of Clark *et al.* (1997) that *Ceratophyllus s. sciurorum* has a self-sustaining clock. Significance tests confirm that feeding weakens the rythm but does not eliminate it. Although there was no significant difference in the mean amount of activity between the fed and the unfed fleas, there was a difference in the number of hours, over which the activity took place.

K. S. Larsen

9.2 The cat flea *Ctenocephalides felis*

9.2.1 Control of artificial cat flea infestation on cats with Program Vet® (lufenuron) and CGA 246’916

The purpose of the study was to evaluate the efficacy of an orally administered adulticide (CGA 246’916, nitenpyram) in cats treated with Program Vet® (lufenuron) for control of the cat flea *Ctenocephalides felis*. The effect of this treatment was compared by observing cats given either a Program Vet® or a CGA 246’916 treatment only or no treatment (control). The products were tested on flea-infested cats kept in laboratory cages.

A higher level of egg hatching and fleas reaching adulthood was observed immediately after administration of Program Vet® in the group of cats treated with CGA 246’916 and Program Vet® (group 2), compared to the cats given Program Vet® only (group 1). However, full control was obtained after two days which is the normal period for lufenuron to be fully absorbed by the cats.

The Program Vet® treatment of the cats (group 1) gave 98-100 per cent control of the development of the eggs into adult fleas. This level of efficacy was observed from 2 days to 30 days after the products were administered.

An immediate and complete effect of the CGA 246'916 was observed after each treatment of the flea-infested cats (groups 2 and 3). The number of eggs produced decreased immediately. Further, no fleas were found in these two groups when the cats were combed at the end of the trial. This showed that the decrease of egg production was due to the adulticide activity of CGA 246'916 and not an effect on egg production. The persistence of the treatment is less than five days as flea reinfestations of the cats were successful five days after the weekly treatments.

K. S. Larsen

10. Arthropod pests in poultry production

10.1 Prevalence of the chicken mite

The chicken mite, *Dermanyssus gallinae*, is a well known ectoparasite of poultry. In May 1997, a questionnaire was sent to approximately 400 Danish egg producers including different types of production facilities. The questions concentrated on the presence of chicken mites and what problems they may have caused. Almost 40% of the farmers answered the questionnaire and the results showed that approximately one third had chicken mites at that time. The lowest incidence of chicken mites was found among the organic egg producers, where only 14% had chicken mites. This is probably due to the low age of these production units which was only 3 years on average. In contrast to what is generally assumed, a relatively high incidence was also found in the battery systems (28%).

Table A0a. Answers to the question: "When was the last time you had chicken mites?"

	Battery	*Barn*	*Free-range*	*Organic*	*Total*
At present	28%	40%	39%	14%	31%
Last 3 years	4%	10%	29%	21%	13%
3-10 years	6%	10%	4%	4%	6%
Never	56%	32%	21%	54%	43%
Unknown	6%	8%	7%	7%	7%
# answers	53	50	28	28	159

The worst problems with chicken mites were observed in July and August, but some farmers reported incidences even in the winter months. As to the question how the hens are affected by the chicken mites, the most common answers were that the birds are disturbed, and more feather picking is observed. However, some farmers reported that they had mites, but they caused no problems.

The relatively low response rate could raise doubt whether these results are representative for all egg producers. Therefore, telephone interviews with 83 farmers in the groups "Barn", "Free-range", and "Organic" were carried out in the autumn of 1997. The largest deviation was seen among the "Barn" group where only 25% reported they had mites in the autumn. In comparison, the positive answers in the "Free-range" and "Organic" groups were 44% and 25%, respectively. This indicates that at least the results from the last two groups show the actual prevalence of chicken mites in these types of egg production.

10.2 Behavioural response of the chicken mite to host related stimuli

During the day time, chicken mites usually remain hidden in cracks and crevices. They only come out to feed during the night. The question is how they find their way to a host. Studies related to this question were initiated in 1997. Several host-related stimuli were found that influenced the behaviour of the mites.

- Temperature changes - resting mites are activated by small increases in temperature.
- Vibrations - mites are activated by vibrations carried through the medium on which they are resting.
- CO_2 - may either activate the mites or increase their attention towards other stimuli depending on the light intensity.

More detailed studies on the effects of these stimuli alone and in combination will be carried out in 1998.

10.3 Aggregation pheromones of the chicken mite

Chicken mites are known to secrete a pheromone that induces an aggregation behaviour of fed mites. In 1997 preliminary experiments were carried out aiming at isolating this pheromone. A new bioassay was developed combining paper chromatography and behavioural studies.

Glass tubes in which large number of mites had been kept for several weeks were washed in ethanol. The ethanol extract was applied on filter paper and various solvents were added. After drying, fed female mites were placed on the paper and left over night in the dark. The aggregation sites of the mites were then taken as indications of the location of the pheromone.

These experiments confirmed the usefulness of this bioassay but separation by means of paper chromatography is not very efficient, and therefore the experiments are continued in 1998 with Thin Layer Chromatography.

O. Kilpinen

10.4 Litter beetles as disease reservoirs

Litter beetles, in particular the lesser mealworm *Alphitobius diaperinus*, the hairy fungus beetle *Typhaea stercorea* and the foreign grain beetle *Ahasverus advena* are commonly found in broiler houses. These beetles are difficult to control chemically, and as their developmental time is rather short, they often constitute a pest problem. In addition they are potential transmitters of disease agents; for salmonella bacteria it has been shown that these species can be infected or surface-contaminated by salmonella bacteria.

The Ministry of Food, Agriculture and Fisheries has therefore supported a project with the following specific objectives: 1) to investigate the occurrence, biology and behaviour of the beetles, 2) to develop and implement strategies for the prevention and control of the beetles, and 3) to investigate if persistent infections with *Salmonella* or *Campylobacter* are related to the occurrence of beetle infestations.

The project involves collaboration between the Danish Veterinary Laboratory, the Danish Poultry Meat Association, the Danish Pest Infestation Laboratory (Project co-ordinator), as well as many veterinarians and poultry meat farmers.

The project was established in 1996, and by now samples of beetles have been collected and analysed for the presence of *Salmonella* and *Campylobacter* from a number of sites across Denmark. This work will continue in 1998. A survey of the distribution and extent of beetle infestation and a study of insecticide resistance are also planned for 1998.

A. Spencer and J. B. Jespersen

10.5 Behaviour and population dynamics of litter beetles in broiler houses

A master's degree project on the population dynamics and behaviour of litter beetles (specifically *Alphitobius diaperinus, Typhaea stercorea, and Ahasverus advena)* in a broiler farm was initiated in September 1996, and is planned to end mid-1998.

All of these species are common pests in stored products world-wide and have therefore been extensively studied in laboratory trials. However, little or no work has been carried out on the field biology of these beetles in chicken production facilities. This project examined population increase, developmental rates, flight activity and habitat preferences in a commercial broiler facility for the beetle species mentioned above. The investigation was carried out as a field study in two six-week periods. A new trap design was used in the experiment and was therefore tested as part of the study. All experiments were carried out on a Danish broiler farm on Funen.

The development times from egg to adult emergence of *T. stercorea*, *A. diaperinus* and *A. advena* were estimated to be approximately three weeks, four weeks and five to six weeks, respectively. All three species were therefore only able to complete one generation within one chicken rearing period of six weeks. *T. stercorea* and *A. advena* were observed to leave the litter shortly after adult emergence. All three species had a distinct preference for a particular environment and the distribution of the two large fungus feeders, *T. stercorea* and *A. advena*, was closely correlated in all samples. *A. advena* was the only beetle to fly in significant numbers.

Tube traps were well suited for monitoring the activity of adult *T. stercorea*, *A advena* and *A. diaperinus* adult and larvae in the litter. Bait bags were well suited for monitoring of the activity of *T. stercorea* and *A. advena* on the walls.

A full description of the investigation is now being published as a master's thesis by L. D. Erichsen; the results will later be published as a formal paper.

L. D. Erichsen and J. B. Jespersen

10.6 *Typhaea stercorea*, a carrier of *Salmonella* in a Danish broiler house

In a collaborative project with the Danish Veterinary Laboratory, the ability of the hairy fungus beetle *Typhaea stercorea* to act as a carrier of *Salmonella infantis* in a broiler house between broiler rearing cycles was investigated. The investigations were partly carried out in a broiler house with a permanent *S. infantis* infection, and partly as a laboratory trial, where specified pathogen-free chicks were fed with *S. infantis* positive *T. stercorea* collected from the broiler house. It was concluded that *T. stercorea* may act as a potential carrier of *S. infantis* between successive broiler cycles.

The results are detailed in a paper by B. Hald, A.Olsen and M. Madsen entitled "*Typhaea stercorea* (Coleoptera: Mycetophagidae), a carrier of *Salmonella* enterica serovar Infantis in a Danish Broiler House" (In Press) *Journal of Economic Entomology 1998.*

J. B. Jespersen

10.7 Entomopathogenic fungi for control of litter beetles

In 1996 a survey was conducted of the natural occurrence of entomo-pathogenic fungi in litter beetles. Beetles from only five locations (N=45) were infected by entomopathogenic fungi, and the fungus prevalence was low not only for he lesser mealworm (*Alphitobius diaperinus*) but also for other potential beetle pests in poultry farms (*Typhaea stercorea*, *Ahasverus advena*). However, despite the limited natural occurrence of entomo-pathogenic fungi, a previous screening showed that larvae of the lesser mealworm (*Alphitobis diaperinus*) were susceptible to strains of most species of hyphomycetes tested (*Beauveria bassiana*, *B. brongniartii*, *Paecilomyces farinosus*, *P. fumosoroseus*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Acremonium* sp. and *Fusarium* sp.). Tests with *B. bassiana*, *M. anisopliae* and *P. fumosoroseus* confirmed earlier obser-vations that larvae and pupae were much more susceptible to infection than adults. Bioassays, in which insects were immersed in aqueous spore suspensions, showed that it was possible to select fungal strains that were not only highly pathogenic to larvae but also showed relatively high pathogenicity against adult beetles. These strains will be tested in cage experiments to evaluate their potential for spread in populations of the lesser mealworm.

T. Steenberg and J. B. Jespersen

10.8 The potential of entomopathogenic nematodes as biological control agents of *Typhaea stercorea* (L.) (Coleoptera: Mycetophagidae) in broiler houses

Insecticides have been used in attempt to control *Typhaea stercorea*. However, an integrated approach (IPM), which includes biological control, is suggested as a better and more sustainable way to control the beetle. One group of biological control agents is entomopathogenic nematodes and their associated bacteria, which are unharmful to vertebrates, and therefore have potential as biological control agents in broiler houses.

The susceptibility of immature and adult *Typhaea stercorea* to four entomopathogenic nematode species was tested on filter paper. One nematode species, *Steinernema carpocapsae*, proved to be more effective against *T. stercorea* than the others and was selected for further studies. The persistence and virulence of *S. carpocapsae* were tested in several combinations of wet chickenfeed, wheat, straw and capillary matting (used in plant nurseries) with the intention of creating a bait system that would attract the beetles and protect the nematodes from adverse effect of the chicken manure. The efficiency of *S. carpocapsae* was particularly high in a combination of chickenfeed and capillary matting with a moisture content of 50-55% wet weight, at 26°C, 100% RH. However, when the relative humidity was 70% RH, which is representative for the conditions in the broiler houses, the pathogenicity of the nematodes was limited.

The efficiency of the chickenfeed bait and a similar wheat bait placed in tube traps was tested in chicken litter with beetles in large plastic containers. After 72 and 120 hours of exposure time, only few beetles were found inside the tube traps. However, dead beetles found outside the tubes were infected with nematodes, indicating that some beetles had invaded the tubes and therefore had the potential to spread the nematodes to the litter and thus to other beetles.
For the time being the combination of the limited attraction ability of the bait system in chicken litter and the limited persistence of the nematodes in

the bait - when placed under realistic humidity levels - makes the bait and tube trap system incomplete for the use of controlling *T. stercorea* in broiler houses.

T. S. Mortensen

10.9 Chemical control of litter beetles in a parent flock farm

The lesser mealworm *Alphitobius diaperinus* (together with certain other beetle species) is a problem in the egg production houses of parent flock farms, which produce eggs for broiler production. The problems are mainly related to the damage that the beetles cause to the insulation of the houses and the potential of the beetles to act as reservoirs for pathogens, in particular salmonella.

A field test was carried out to evaluate the efficacy of treatments made with Baycidal WP 25 alone or in combination with Baythion-EC or Solfac WP 10 to control litter beetles (in particular *A. diaperinus*) in such parent flocks. The active ingredients in Baycidal WP 25, Baythion-EC, and Solfac WP 10 are triflumuron, phoxim and cyfluthrin, respectively.

The test was carried out in a parent flock in South Jutland and ran from February 1997 until January 1998. The farm comprises eight houses, separated by a feed alley. One week before new hens were introduced, two of the houses were sprayed with Baythion-EC, while two other houses were sprayed with Solfac WP 10. In both cases the treatment involved spraying the walls up to one metre above ground level, and spraying the floor up to one metre from the walls. These four houses, together with two further houses, were treated with Baycidal WP 25 at different intervals from April to December. The Baycidal WP 25 treatments involved topical application to the manure heaps under the slats. Two houses were left as untreated controls.

The efficacy of the treatments was monitored every two weeks by the placement of 10 tube traps in each house between one and three days on the top of manure, out of reach of the hens. All the treatment strategies successfully controlled *A. diaperinus* in the six treated poultry houses, whereas in the two untreated control houses the number of *A. diaperinus* increased steadily during the period.

J. B.Jespersen and M. K Lauridsen

11. Wood-boring pests

11.1 The common furniture beetle *Anobium punctatum* in museum objects and historic buildings

The results of three years of monitoring of the activity of *Anobium punctatum* and wood moisture content in the roof spaces (lofts) of nine Danish churches were analysed to find possible correlations between pest activity and wood moisture content.

In three churches no activity was found. In the six churches with active infestations, the activity levels were very low. However, the results from the three different monitoring methods applied in 1996 support each other; in lofts with many new exit holes, more beetles were found on the traps (Kirk fly stop and Anobid trap). A high degree of association ($p<0.05$, $\chi^2= 12.78$) was found between the activity levels determined by the different methods in a particular church; thus it can be concluded that the activity level is highest in Tågerup Church, followed by Errindlev, Olstrup, Valløby, Lundtofte and lowest in Lellinge Church.

The wood moisture content was monitored by means of recordings of the resistance between two electrodes imbedded in a dowel made of beech wood (length: 33 mm; dia.: 10 mm). The dowels were inserted permanently into tightly fitting holes bored in the timber, 4-6 dowels in each church loft. Recordings were made every 4-6 weeks during the first year, every 3 weeks during the second year and every 2 weeks during the third year.

The recordings of the wood moisture contents in each loft are shown in Figure 1. It can be seen that the values in some lofts are consistently lower than in the others, e.g. Lellinge as opposed to Valløby.

By means of regression analysis and co-variance analysis it was found that the wood moisture levels in Errindlev, Olstrup and Valløby were significantly higher than those in Lellinge, Tågerup and Lundtofte. In most cases, higher *Anobium punctatum* activity coincides with a higher wood moisture level, which thus seems to play an important role in determining the development rate of the pest.

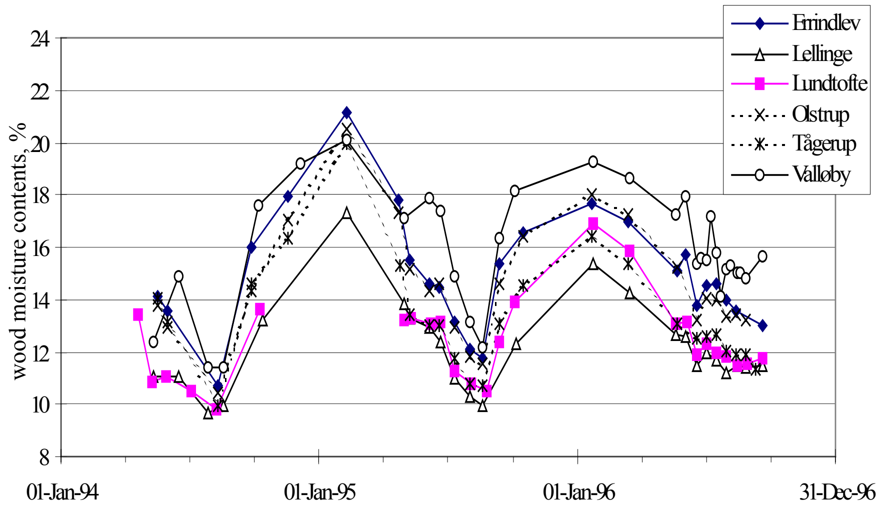

Figure 11a. Wood moisture levels in unheated lofts of six Danish churches monitored for 2½ years. Each value is the mean of recordings of the electric resistance at 12 mm depth in timber in 4-6 permanent locations in each loft space.

A full account of the project results will become available in Danish in 1998.

L. S. Hansen

12. Stored product pests

12.1 Official examination of consignments 1997

The DPIL examines consignments of grain and other dried plant products intended for export. Based on the result of these examinations, the Plant Directorate of the Ministry of Food, Agriculture and Fisheries issues a phytosanitary certificate. In 1997 a total of 744 consignments were examined: 186 grain lots, 112 lots of malt, 58 consignments of tobacco, 100 lots of dried peas and 291 consignments of other products. Live insects were found in 1.2% of the consignments, mainly in grain lots. The following pest spe-cies were detected:

Number of lots	Pest species
3	*Sitophilus granarius*
3	*Oryzaephilus surinamensis*
2	*Tribolium confusum*
1	*Ptinus fur*

L. S. Hansen

12.2 Allergens from pests in grain stores and milled products

The purpose of the present work was to describe the population dynamics of the mite *Lepidoglyphus destructor* and its production of allergens in stored grain. Results have been presented in previous Annual Reports, and further analysis has been carried out in 1997.

The development of *L. destructor* and its production of a major allergen in whole grain (*lep d* 2, formerly *lep d* 1) was investigated in the laboratory. Under controlled conditions the growth rate for *L. destructor* was found at combinations of three levels of relative humidity (70-90% RH) and four temperatures (5-20°C) for 2-3 mite generations. The development of *L. destructor* was succesfully described by a simulation model for each combination of temperature and relative humidity and growth rates were calculated. At 5-20°C the intrinsic rate of increase (r_m) ranged between 0.0009 and 0.13 mites per day. The number of *L. destructor* was analysed by a linear statistical model in which the number of mites is a function of relative humidity, temperature and time. In subsequent analyses high relative humidity (83-90%) and temperatures of 16-22°C were determined as optimal values.

The development of the stage distribution of the mites through the generations may explain some elements of the population dynamics. At 10-20°C the population was initially characterized by a dominance of adults, which were quickly followed by larvae and protonymphs. These protonymphs could be expected to develop into tritonymphs, but only a few tritonymphs were found. They might have entered the hypopus stage instead, possibly due to exhaustion of the food source. The density of the hypopus stage can-not be determined by the extraction method used in the experiments (Berlese funnel).

A linear statistical model was used for deciding whether the number of mites, relative humidity, temperature and time had an effect on the allergen content of the grain sample. Regression analysis showed that all factors except the relative humidity were highly significant (R^2=59%). However, the ELISA method used for the determination of *lep d* 2 needs improvement before it can be put into commercial use.

C. Danielsen's Ph.D. thesis will be submitted in 1998.

C. Danielsen and L. S. Hansen

12.3 Biological control of the Mediterranean flour moth *Ephestia kuehniella*

This project deals with the possibilities of using natural enemies for control of the major pest in flour mills, the Mediterranean flour moth *Ephestia kuehniella*. The total phase-out of methyl bromide in Denmark on January 1, 1998 has forced the mills to consider other methods of pest control. Biological control is one of several options.

A distributed-delay simulation model was developed to describe the population dynamics of the flour moth. Parameters for temperature-dependent development of eggs, larvae and pupae and the lifespan and fecundity of female moths were obtained from published data. The model was validated against three years of pheromone trap catches of male moths in a Danish mill. Outside temperatures with an increase of 5°C were used to drive the model. The overall phenology of the flour moth population was well simulated and was found to be determined largely by the stipulated mill temperatures and the seasonality of diapausing larvae. The model estimates that the moth realizes 1-3% of its reproductive potential from one year to the next. Reduced fecundity and juvenile mortality seem to be the most likely regulating factors.

A submodel of a natural enemy, the egg parasitoid *Trichogramma pretiosum,* was developed from published life table data. Simulations indicate that if parasitoids are released early in the season, and if they realize their full reproduction potential, the flour moth population can be suppressed considerably during the summer months. However, since little information is available about the present factors regulating *E. kuehniella* in the mills, precaution must be taken when extrapolating from such simulation results to the field situation.

A monitoring programme is being conducted to elucidate actual climatic conditions in industrial flour mills. Temperature and humidity conditions have been monitored in two industrial mills for a year. It appeared that average daily temperatures in some areas are generally about 5°C above the outside temperature, ranging from 3° to 30°C, while in other areas heat coming from machinery maintains temperatures consistently above 15°C. An example of this can be seen in Figure 12a.

This difference in temperature conditions is reflected in the presence of flour moths in pheromone traps: in warm areas, flour moths were found when the monitoring programme started in February, whereas in the cooler areas, pests were not found until May or June.

The monitoring programme included investigations of the presence of egg parasitoids or predators; batches of UV-sterilized *Ephestia kuehniella* eggs were placed in the mills and renewed weekly to check for signs of natural enemies. No activity was found, however.

Investigations are being conducted in chambers with controlled climate con-ditions to elucidate the effect of temperature on pheromone trap catches. Preliminary results have shown that temperature has an important influence on the catch rates of released male flour moths (<24 hours old). The investigations will be continued to identify upper and lower temperature limits for flight activity.

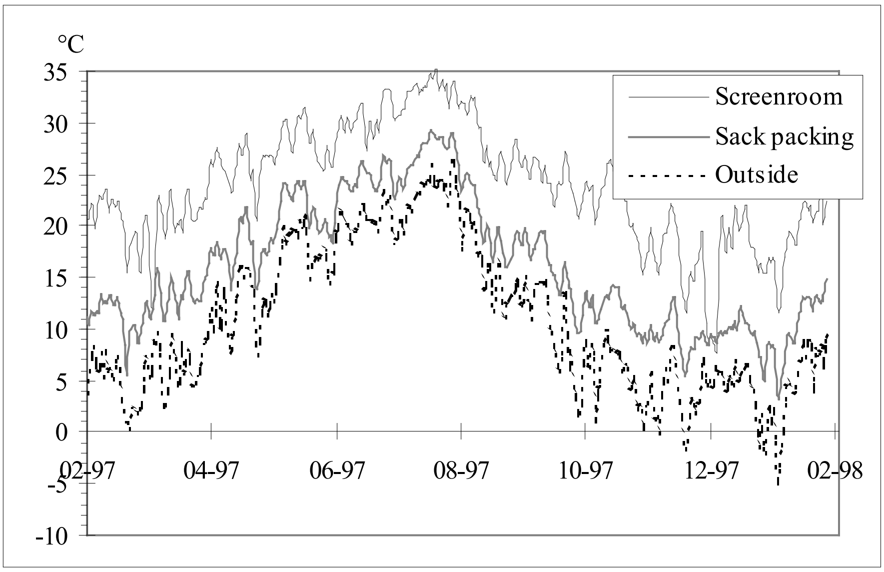

Figure 12a. Examples of mean daily temperatures from an industrial flour mill, compared with the temperature recorded outside the mill. The screenroom area illustrates temperatures in warm mill areas, while the sack packing area is cooler.

Two species of natural enemies have been chosen for further studies: a predatory mite, *Blattisocius tarsalis,* and an egg parasitoid *Trichogramma evanescens*, the "Lager" strain, which is a strain that has given promising results against stored product moths in investigations conducted at the BBA, Institute for Stored Product Protection, Berlin. Both species attack the egg stage of *Ephestia kuehniella*, which is considered essential in the present context, for the following reasons: (i) it is important to avoid development of larvae and their webbing; (ii) the eggs of *E. kuehniella* are laid on top of accumulations of flour and are thus more accessible than the larvae which burrow into the food medium.

Both species of natural enemies have been established in the laboratory.

Blattisocius tarsalis was found on adult *E. kuehniella* collected in a flour mill; this phoretic mite obviously occurs naturally in Denmark. *B. tarsalis* has been studied intensively during 1997. The relationship between temperature, prey abundance and predation rate has been studied in the laboratory. At temperatures as low as 15°C the predation rate is 1.5 moth eggs per female mite per day, which supports the supposition that this mite is a promising candidate for biological control of *E. kuehniella*. All age groups of *E. kuehniella*-eggs are attacked by adult *B. tarsalis. B. tarsalis* is a surface predator and does not penetrate into the flour.

L. S. Hansen, N. Holst, C. Nansen,
P. S. Nielsen, and H. S. Pedersen

12.4 The effect of low oxygen pressure on museum pests

The possibilities of controlling various museum pests, mainly dermestid species, by means of modified atmospheres, such as low oxygen pressure, are being investigated. The investigations are carried out in collaboration with the DPIL, J.-E. Bergh, PRE-MAL, Sweden and P. Væggemose Nielsen, Danish Technical University.

The following species, if possible in all stages, are being used for the experiments: *Attagenus woodroffei, At. smirnovi, Anthrenus museorum, An. verbasci, Reesa vespulae, Trogoderma angustum, Tineola bisseliella* and *Ptinus tectus*. Test specimens are exposed to <0.3% oxygen at 25°C, 55% RH for exposure times of 6-72 hours. The first two test series indicate that *An. verbasci, P. tectus* and *T. angustum* are more tolerant than *Ant. museorum*.

L. S. Hansen

12.5 Implementation of integrated pest management (IPM) in industrial flour mills

Due to the fact that methyl bromide will be totally prohibited in Denmark from 1 January 1998, the Danish Environmental Protection Agency has in December 1997 financed a project on the introduction of IPM strategies in three Danish flour mills. The project is carried out by the mills and a PCO-company under the supervision of the Danish Pest Infestation Laboratory.

In the past the Danish flour mills relied on a pest control strategy, which includes fumigation with methyl bromide once or twice a year in order to prevent problems with primarily *Ephestia kuehniella* and *Tribolium*-species. As now the mills have to base their pest control on a combination of other methods it was found relevant to use the IPM concept in the flour mills.

The goal of the project is to design individual IPM strategies in each flour mill and to initiate the implementation of these strategies. Although various IPM strategies are used in mills world-wide, these strategies often rely on methyl bromide, and there are only few documented investigations on IPM in food processing factories available in the literature.

P. S. Nielsen

13. Various other arthropods

13.1 Mosquitoes. Evaluation of repellents.

Two products intended for personal protection against mosquitoes were delivered by Danish companies for testing under field conditions. They both contained plant essential oils as the active ingredients; one formulation contained eucalyptus oil while the other contained a mixture of citronella, lemongrass, and eucalyptus, and geranium oil. The eucalyptus-based repellent was made for application to the skin and the other was a wrist band with the essential olie imbedded in polyethylene plastic.

The eucalyptus-based repellent gives an acceptable protection for at least two hours when tested in a typical Danish forest at a time of the year when mosquito nuisance is at its highest level. The level of repellency was similar to a commercial N,N-diethyl-m-toluamide containing repellent for the first two hours after application. There was no repellent effect of the wrist band.

M. Kristensen and C. Nansen

13.2 Treated packing materials for the protection of textiles in museums

In the Danish Pest Infestation Laboratory Annual Report 1996 we reported the results from the first part of a project concerning the possibilities of protecting textiles from insect damages by the use of treated packing materials. The investigations comprised assessment of the immediate effect as well as the possibilities for long term protection, i.e. after 12 and 24 months. The two insecticides were: α-cypermethrin (40 mg a.i./m²) and microencapsulated diazinon (50 mg a.i./m²). Three packing situations were simulated: a piece of woollen cloth was wrapped loosely in two pieces of untreated tissue paper and then either: (1) wrapped in a layer of tissue paper treated on the outer side, (2) placed in a cardboard box that was treated on the outside, or (3) placed on a treated wooden shelf.

Larvae of five species of Dermestid beetles were then exposed to these units. The species involved were: *Anthrenus verbasci, Attagenus unicolor, Attagenus museorum, Reesa vespulae* and *Trogoderma angustum*. The extent of damage to the woollen cloth as well as mortality of the larvae were assessed 70 days after the larvae were introduced.

Test series were carried out after half a month with both active ingredients and after 12 months with α-cypermethrin (the 12 month trial with diazinon will be done in 1998). Half a month after the treatment, neither of the formulations could offer a good protection when used on shelves or on cardboard boxes, whereas the use of an extra piece of treated tissue for wrapping of the woollen cloth was effective. After 12 months α-cypermethrin could still not provide sufficient protection when used on shelves or on cardboard boxes. The use of an extra piece of treated tissue for wrapping of the woollen cloth led to good protection although little damage was observed in the units with *Anthrenus verbasci*. Further tests are recommended to optimize the doses and to formulate "insecticidal tissue paper" for wrapping of museum artefacts. Based on the information given, the above test can be based on investigations with *A. verbasci* alone.

The investigations are being carried out in collaboration with the Swedish group "PRE-MAL" (Pest Research Education - Museums, Archives and Libraries).

K.-M. V. Jensen and L. S. Hansen

14. Rodents

14.1 Efficacy testing

14.1.1 Bromadiolone

The efficacy and palatability of an 0.005% bromadiolone wax block formulation were tested on brown rats (*Rattus norvegicus*) in two room tests and two single-cage choice tests. The single-cage tests revealed neophobic reactions, a low acceptance and a mortality of 50-80% only. The room tests, however, showed a good acceptance and a mortality of 90-100%. This compensates for the low acceptance in single cages and this formulation could therefore be approved for control.

M. Carlsen, H. Leirs, and J. Lodal

14.1.2 Difenacoum

The efficacy and palatability of an 0.01% difenacoum paste formulation were tested on brown rats (*Rattus norvegicus*) in two room tests and one single-cage choice test. The paste was generally well accepted but there was a high individual variation. Although the results of the two room tests were very different, mortality was high. This paste formulation was approved for rat control.

H. Leirs and J. Lodal

14.1.3 Difenacoum, LD_{50}

At the request of a foreign company, the acute LD_{50} for difenacoum was determined in roof rats (*Rattus rattus*) by oral intubation.

J. Lodal

14.1.4 Plaster baits as rodenticides

In mid-1997, articles and letters in the popular press in Denmark claimed that rats could effectively be controlled by applying baits based on plaster (powdered gypsum, $CaSO_4.2H_2O$), and DPIL received questions about this issue. Although the product is or has been available as a commercial rodenticide in some countries, there is no scientific literature about its effectiveness. Therefore, it was decided to test this in the laboratory.

A bait was prepared by the mixing of 50% plaster powder, 1% sugar and 49% rolled oats, corresponding to a commercial formulation. Ten adult *Rattus norvegicus* (5 males, 5 females) from DPIL's own laboratory strain of anticoagulant susceptible rats were caged singly. The animals were allowed to acclimatize for one week during which they received rye bread and water ad lib. At the start of the test period, each animal was offered 30 g of the experimental bait. Consumption was monitored by weighing the remaining bait daily (except on Sunday) for a one week period. Every day, the amount of bait was replenished to 30 g per cage, on Saturday 40 g. Water was available ad lib. throughout the test period. The condition of the animals was checked daily. After the experiment, the animals were placed in observation for 16 more days, during which they received rye bread as food. At the end of the experiment, the animals were killed.

All animals ate considerable amounts of the experimental bait: total individual uptake during the test period (mean $\pm$ st.dev) reached 89.54 $\pm$ 39.57 g bait, or 120.65 $\pm$ 59.97 g plaster/kg body weight. During the experiment, they produced hard and white excrements, showing that the plaster was indeed ingested. Small traces of blood could be seen in the excrements after day 4. Three animals learned to efficiently separate the oats and the plaster in the bait; from day 4 onwards, the bait dish in their cages contained loose left-over plaster and their excrements did no longer show the white colour. Water consumption was normal. None of the animals died, and none showed any signs of distress or bad condition during the test.

It was concluded that a plaster bait is accepted by the rats, but it does not cause any mortality within a week of non-choice feeding. This bait formulation is not suitable as a rodenticide.

H. Leirs and J. Lodal

14.2 Palatability testing

14.2.1 Bromadiolone liquid poisons

At the request of a Danish company eight different formulations of a bromadiolone liquid poison were screened as to how well they were accepted by brown rats (*R. norvegicus*). All formulations contained 0.01% bromadiolone and to seven of them had been added different flavourings which were expected to increase the palatability. The rats did not clearly prefer one of the formulations to the others. Another important aspect was a low mortality in one test over three days in spite of a theoretically sufficient amount of bromadiolone consumed.

Two room tests with 0.01% bromadiolone liquid poison against brown rats (*R. norvegicus*) were conducted after the above-mentioned tests. The morta-lity was 0/10 and 1/10, respectively, after a four-day test period with a choice between the bromadiolone poison and non-poisonous tap water. A higher mortality might have been expected in both tests based on the calculated theoretical amounts of bromadiolone consumed per kg body weight.

J. Lodal

14.3 Resistance to anticoagulants

14.3.1 Resistance in the brown rat

During 1997, 496 brown rats (*R. norvegicus*) were received for anticoagulant resistance testing. New municipalities where resistance has been found are: coumatetralyl in Brøndby, Sorø, Vordingborg, Fredericia and Rødding; and bromadiolone in Vordingborg, Fredericia and Rødding. Decreased susceptibility to bromadiolone was found in Sorø and to difenacoum in Vordingborg and Rødding.

J. Lodal

14.4 Other works on rodents and rodent management

14.4.1 Rat trap

At the request of a Danish inventor a special trap was tested in the laboratory. This special trap is a killing trap constructed to take several rats before emptying. The aim of the test series was to find the most optimal solution to some construction details of the trap. Therefore, different prototypes were presented to groups of rats in order to analyse the effect of different materials, shape of entrance and some other factors. After having entered the trap, rats are automatically killed with CO_2. It was found that the concentration of CO_2 should not be lower than 60% by volume in order to kill the rats.

J. Lodal

14.4.2 Mammals crossing Øresund

At the request of one of the contractors involved in the construction of the Fixed Link over Øresund the risks associated with mammals crossing the bridge and tunnel between Denmark and Sweden have been evaluated. The main concern is the risk of direct damage to the construction and its installations that may be caused by the mammals and how to reduce it. Another aspect is a possible transmission of diseases by the animals.

H. Leirs and J. Lodal

14.4.3 Field voles *Microtus agrestis* and predation

Throughout 1997 the Ph.D. project "The importance of predation for populations of *Microtus agrestis* in fragmented habitats" (initiated in 1995) has been dominated by intensive field work. The gathered data still await thorough analysis. This will mainly be done in 1998.

The present results, however, indicate that predator exclusion does have an effect. In the exclosures the voles have a slightly better survival, but above all, they are in better condition, i.e. their weight development is more positive leading to higher mean weights and earlier reproduction. Also numbers are more stable and at their highest in exclosures. The predator-enriched areas have the lowest numbers, but the difference between these areas and the controls is more vague than the difference between controls and exclosures.

M. Carlsen

14.4.4 Population ecology of the African field rat *Mastomys natalensis*

Based on earlier capture-recapture data collected in Tanzania and the use of advanced statistical analysis, the demography of Afrcan field rats *Mastomys natalensis* was analyzed. These rodents are common agricultural pests and carriers of diseases in subsaharan Africa. The results showed simultaneous occurrence of density-dependent and density-independent (rainfall-related) variations in survival and maturation parameters in this species. Incorporation of the obtained estimates of demographic rates in a population dynamics model showed that the observed dynamics are affected by stabilizing non-linear density-dependent components coupled with strong deterministic and stochastic seasonal components. The obtained model can be used to predict future development of a *Mastomys* population, given a number of rainfall and density conditions, and this is useful in the forecasting of outbreaks or the simulation of possible management strategies. Currently, work is in progress to test the practical applicability of such approaches.

In an earlier and more simple formulation of the population dynamics model, it was already claimed that early rainfall played a major role in initiating reproduction and through this affected the population size. Analysis of capture data from four different localities in Tanzania showed that this was indeed the case, but not in areas where early rains were commonly abundant. Similar work is going on in grassland and maize fields in central Ethiopia, and suggests that rodent population dynamics also in this area are linked to rainfall patterns. Experiments in Tanzania also showed that a single control action undertaken at planting time does not persist long enough to protect seedlings, probably due to quick reinvasion of the treated fields by rodents from the surroundings.

Data from another 3-year (1994-1997) capture-recapture study with *M. natalensis* in a small scale maize field-fallow land mosaic in Tanzania were used to investigate habitat effects on population dynamics. The seasonal evolution of rodent presence was the same in both habitat types and it was not affected by agricultural activities in the fields. About one week after planting, there was a short increase of rodent captures in the maize fields, but this disappeared again after a few days. Recolonization of fields was achieved very fast after a rodent control operation. Radiotelemetry indicated that many individuals were active in the maize field as well as in the fallow land. In conclusion, the field and fallow land rodent populations in a small-scale setup are not separated. This renders several rodent control approaches unsuitable. In order to investigate the spatial components of *Mastomys* population dynamics in more detail, in particular also the differences between monoculture and mosaic farming systems, as well as the problem of recolonization of fields after rodent control, further data are now being collected.

Several observations indicate that predation may be a major cause of death in *Mastomys* populations. This suggests that biological control of these rodents could be a possible management strategy. In a six-month pilot study in Morogoro, Tanzania, populations were followed on experimental fields with decreased control and increased predation pressure. The data showed an increased survival on a field where avian predators were excluded but no effects of placing perches. This study is now being expanded in a large replicated setup where fields are manipulated for predation pressure and controlled for compensatory dispersal effects.

H. Leirs

14.4.5 Search for the vertebrate reservoir of Ebola virus

During the 1995 outbreak of Ebola Haemorrhagic Fever in Kikwit, Democratic Republic of the Congo, an international team under auspices of the WHO collected 3066 vertebrates, mainly small mammals, in the surroundings of the site, where the putative primary case probably became infected. All collected samples were tested for Ebola virus isolation or serology at the Centers for Disease Control in Atlanta, USA, but all were negative. The identification of the different specimens happened in the laboratories of relevant taxonomists but all data were afterwards grouped and analysed at DPIL. Several explanations were identified for the negative result despite the large field efforts: the investigation was hampered by lack of information beyond the daily activities of the primary case, lack of information on Ebola virus ecology, which precluded the detailed study of select groups of animals, and sample size limitations for rare species. Furthermore, the epidemiology of Ebola hemorrhagic fever suggests that humans have only intermittent contact with the virus, which complicates selection of target species. Nevertheless, making a large and diverse collection remains an appropriate approach during future Ebola outbreaks.

H. Leirs

14.4.6 Alternatives to methyl bromide. Control of rodents on ship and aircraft

A report describing the current use of methyl bromide as a pesticide in the Nordic countries for on-board ship and aircraft fumigation was commissioned by the Nordic Council of Ministers/The Chemical Group.

Methyl bromide is the fumigant currently allowed for quarantine treatments on ships and aircraft in the Nordic countries. Methyl bromide is not used in Iceland. Its use was terminated in Denmark, Sweden and Finland by January 1, 1998. Norway has adopted the Nordic Strategy and is at present working on regulations of import and consumption of methyl bromide.

In the years 1992-1996 methyl bromide was used for on board ship fumigation 1-2 times per year in the Nordic countries, and 2 aircraft fumigations were performed. The low incidence of methyl bromide strongly questions the need of sustaining this pest control technique, since control can be performed by other measures.

There is no single alternative fumigant which meets the specifications wanted: fast and efficient with high penetration at low temperatures and under humid conditions, not causing damage to the vessel and to be used on food or feed products.

Sulfuryl fluoride is the single compound closest to meeting the wanted specifications, but it is not registered for use on food or feed crops.

Hydrogen cyanide and phosphine are good alternatives in dry and hot conditions, but cause many different problems in cold and humid conditions. In general they do not meet the specifications defined for an alternative fumigant in the Nordic countries.

Controlled atmospheres, carbonyl sulfide, and recovery of methyl bromide, are not applicable alternatives for on-board ship or aboard aircraft fumigation.
The most obvious alternative for ships is traditional rodent control performed by professional pest control operators. This is the way most rodent infestations are treated at present in the Nordic countries. The problem of this is time, which might be overcome by (1) preventive

measures against rodents; (2) early treatment starting several days in advance of reaching port; (3) strict enforcement of quarantine rules; 4) ships should be able to receive deratting certificates without going out business after, e.g. a period of 4 weeks where a professional pest control company or network of companies is responsible for the deratting.

Fumigation of aircraft for the control of rodents is not recommended, since a dying or a dead rodent might cause as much damage as a live rodent. Removal of rodents from aircraft is considered a very difficult situation, but can be achieved within a relatively short period. Methyl bromide fumigation of aircraft to control insects, especially cockroaches, must be considered as an overkill reaction and is not needed as control can be obtained more easily or better by conventional measures.

Recommendations: 1) methyl bromide is no longer to be used for fumigation of ships and aircraft; 2) no alternative fumigant is needed or recommended, except locally in very extreme situations; 3) ships should be able to receive deratting certificates following treatment in port and at sea during a period of 3-6 weeks by licensed pest control companies.

M. Kristensen

15. List of species maintained at the DPIL

The numbers in square brackets [a,b] after some of the species indicate the following: a = the number of strains kept at the DPIL; b = the number of resistant strains (if tested); - = no information is available.

ARACHNIDA	**SPINDLER**
Acarina	**Mider**
Lepidoglyphus destructor	Kornmide
Blattisocius tarsalis	Rovmide
INSECTA	**INSEKTER**
Thysanura	**Børstehaler**
Lepisma saccharina	Sølvkræ
Blattaria	**Kakerlakker**
Blatta orientalis	Orientalsk kakerlak
Blattella germanica [7,5]	Tysk kakerlak
Periplaneta americana	Amerikansk kakerlak
Supella longipalpa	Brunstribet kakerlak
Lepidoptera	**Sommerfugle**
Ephestia kuehniella	Melmøl
Plodia interpunctella	Tofarvet frømøl
Tinea pellionella	Pelsmøl
Tineola bisselliella	Klædemøl
Coleoptera	**Biller**
Anthrenus museorum	Museumsklanner
Anthrenus verbasci	Almindelig tæppebille
Attagenus smirnovi	Brun pelsklanner
Attagenus unicolor (piceus)	Sort pelsklanner
Attagenus woodroffei	Båndet pelsklanner
Oryzaephilus surinamensis	Savtakket kornbille
Ptinus tectus	Australsk tyvbille
Prostephanus truncatus	(intet dansk navn)
Reesa vespulae	Amerikansk klanner
Sitophilus granarius	Kornsnudebille
Stegobium paniceum	Brødbille

Tribolium confusum	Rismelbille
Trogoderma angustum	Smal frøklanner
Trogoderma granarium	Khaprabille
Diptera	**Tovinger (myg og fluer)**
Fannia canicularis [5,-]	Lille stueflue
Haematobia irritans	Lille stikflue
Musca autumnalis	Kvægflue
Musca domestica [23,20]	Stueflue
Neomyia cornicina (*Orthellia caesarion*)	Grøn kokasseflue
Siphonaptera	**Lopper**
Ctenocephalides felis	Katteloppe
Xenopsylla cheopis	Tropisk rotteloppe
MAMMALIA	**PATTEDYR**
Apodemus sylvaticus	Skovmus
Apodemus flavicollis	Halsbåndmus
Microtus agrestis	Nordmarkmus
Clethrionomys glareolus	Rødmus
Arvicola terrestris	Mosegris
Mus musculus/domesticus [3,1]	Husmus (lys og mørk)
Rattus norvegicus	Brun rotte
Rattus rattus	Husrotte

16. Publications and reports

16.1 Publications by members of staff in 1997/1998

Bekele, A. and H. Leirs, 1997: Population ecology of rodents of maize fields in Central Ethiopia. Belgian Journal of Zoology **127** (Suppl.1): 39-48.

Clark, F., D. Deadman, M. Greenwood and K. S. Larsen, (1997) A circadian rhythm of locomotor activity in the newly emerged *Ceratophyllus sciurorum*, Med. Vet. Entomol. **11**: 213-216.

Denholm I. and J. B. Jespersen, 1998: Insecticide resistance management in Europe: recent developments and prospects. Pesticide Science **52**: 193-195.

Denholm I. and J. B. Jespersen, 1998: ENMARIA - a new initiative in European insecticide and acaricide resistance management. Pesticide Outlook **9**: 31-33.

Denholm I. and J. B. Jespersen, 1998: Introduction to the workshop and background to ENMARIA. 11-17. *in* Gomez, C. & Sandoval, E.V. (Eds.) Pesticide Resistance in Horticultural Crops, edited by Isabel M[a] Cuadrado Gómez and Elisa Viñuela Sandoval, 117 pp. Fudacion para la Investigacion Agraria en la Provencia de Almeria.

Jensen, K.-M. Vagn, 1997: Kakerlakker - findes de ikke mere i Danmark?. LevnedsmiddelBladet: 16-17.

Jensen, T. K., 1997: Undersøgelser af markmusen *Microtus agrestis'* fødepræferencer under laboratorieforhold. Specialeopgave Statens Skadedyrlaboratorium 195-1996. 104pp.

Jespersen, J. B., 1997: Sådan holdes fluerne væk. Hyologisk **5-97**: 32-33.

Jespersen, J. B., 1997: De plagsomme fluer. Råd & Resultater **4-97**: 10-11.

Jespersen, J. B., 1997: Fluebekæmpelse på pelsdyrfarme. Dansk Pelsdyravl **7-97**: 326-328.

Jespersen, J. B. and K.-M. Vagn Jensen, 1998: Fluer og myg: Ektoparasitter i husdyrbruget. Kapitel 11, 151-168, i Parasitær Økologi, edited by J. Grønvold. DSR forlag, Frederiksberg C, p. 186.

Keller, S. and T. Steenberg, 1997: *Neozygites sminthuri* sp. nov. (Zygomycetes, Entomophthorales), a pathogen of the springtail *Sminthurus viridis* L. (Collembola, Sminthuridae). Sydowia **49**: (1):21-24.

Kilpinen, O. and J. Storm, 1997: Biophysics of the subgenual organ of the honeybee, *Apis mellifera*. Journal of Comparative Physiology A **181**: 309-318.

Kristensen, M., 1997: Alternatives to methyl bromide. Control of rodents on ship and aircraft. Nordic Council of Ministers. TemaNord 1997 **513:** 37 pp.

Kristensen, M., A. G. Spencer and J. B. Jespersen, 1998: Development and implementation of biochemical insecticide resistance detection in Danish field strains of *Musca domestica*. Pesticide Science **52**: 195-196.

Leirs, H., J. N. Mills and T. G. Ksiazek, 1997: Hunting Ebola virus in Kikwit: lessons for mammalogists. Abstracts of the 7th International Theriological Congress, Acapulco, Mexico, 213.

Larsen, K. S. and J. Lodal, 1997: Evaluation of systemic insecticides mixed in rodenticide baits for plague vector control. Belgian Journal of Zoology, **127** (suppl.1): 119-127.

Leirs, H. and E. Schockaert (Eds.), 1997: Rodent biology and integrated pest management in Africa. Proceedings of the international workshop held in Morogoro (Tanzania, 21-25 October 1996). Belgian Journal of Zoology, **127** (suppl.1): 180 pp.

Leirs, H., N. C. Stenseth, J. D. Nichols, J. E. Hines, R. Verhagen and W. Verheyen, 1997: Stochastic seasonality and nonlinear density-dependent factors regulate population size in an African rodent. Nature, **389**: 176-180.

Leirs, H. and N. C. Stenseth, 1997: Simulating and forecasting African *Mastomys* populations. Abstracts of the 7th International Theriological Congress, Acapulco, Mexico, 212.

Leirs, H., R. Verhagen, C. A. Sabuni, P. Mwanjabe and W. N.Verheyen, 1997: Spatial dynamics of *Mastomys natalensis* in a field-fallow mosaic in Tanzania. Belgian Journal of Zoology, **127** (suppl.1): 29-38.

Lodal, J., 1997: The mole: a matter of control or conservation. Abstracts, First European Vertebrate Pest Management Conference, 1-3 September 1997, York, UK, 42.

Lodal, J., 1997: Rotteresistens. Nyhedsbrev fra Statens Skadedyrlaboratorium og Miljøstyrelsen, 8 pp.

Mwanjabe, P. and H. Leirs, 1997: An early warning system for IPM-based rodent control in smallholder farming systems in Tanzania. Belgian Journal of Zoology, **127**(suppl.1): 49-58.

Rohrseitz, K. and O. Kilpinen, 1997: Vibration transmission characteristics of the legs of freely standing honeybees. Zoology **100**: 80-84.

Skovgård, H. and J. B. Jespersen, 1997: God fornuft holder fluerne i skak. Økologisk Jordbrug, **151**, 1 p.

Skovgård, H. and P. Päts, 1997: Reduction of stemborer damage by intercropping maize with cowpea. Agriculture, Ecosystems and Environment **62:** 13-19.

Spencer A. G., M. Kristensen and K.-M. Vagn Jensen, 1998: The biochemical detection of insecticide resistance in Danish field populations of the German cockroach *Blattella germanica* (Blattellidae). Pesticide Science **52**: 196-198.

Spencer A. G., N. R. Price and A. Callaghan, 1998: Malathion-specific resistance in a strain of the rust-red grain beetle *Cryptolestes ferrugineus* (Coleoptera: Cucujidae). Bulletin of Entomological Research **88**: 199-206.

Vibe-Petersen, S., 1997: Laboratory rearing of the urine fly *Teichomyza fusca* and observations on feeding and oviposition habits on confined pig farms in Denmark. Specialeopgave Statens Skadedyrlaboratorium. 34 pp.

16.2 Appearances in the media

Hansen, L. S.: Aspects of pest allergens, Danish Broadcasting, 26 January.

Larsen, K. S.: Headlice and resistance problems, DR TV1, 22 June.

Larsen. K. S.: Headlice; before and now, Danish Broadcasting, 3 July.

Larsen, K. S.: Headlice problems, Danish Broadcasting, 25 August.

Larsen, K. S.: Headlice biologi and control, Danish Broadcasting, 4 September.

Larsen, K. S.: Headlice problems, TV Danmark and TV2, 27 November.

Lodal, J.: Rats as pests, Danish Broadcasting, 26 January.

Lodal, J.: Traps for rats and mice, TV2, 6 May.

Lodal, J.: Traps for rats and mice, TV3, 6 May.

Lodal, J.: Traps for rats and mice, TV Danmark, 6 May.

Lodal, J.: Mice: damage and control, TV2 Bornholm, 9 September.

Lodal, J.: Rats: rat control and resistance problems, Danish Broadcasting, 20 September.

Lodal, J.: Rats and rat control, DR TV1, 26 November.

Nielsen, P. S.: Household pests, Danish Broadcasting, 13 March.

16.3 Unpublished reports on laboratory tests and/or field trials

The reports are confidential except those marked *

1-1997 Lauridsen, M. K., and J. B. Jespersen: Rapport over biologisk afprøvning af Kill-it Staldspray N. (4 pp.)

2-1997 Lauridsen, M. K., and J. B. Jespersen: Preliminary field evaluation of KBJ 2119 for control of the housefly *Musca Domestica*. (14 pp.)

3-1997 Jensen, K.-M. V.: Field studies on the response of *Lasius niger* to two chlorpyrifos formulations. (21 pp.)

4-1997 Larsen, K. S. and J. Lodal: Rodent biology and integrated pest management in public health and agriculture in East Africa. (11 pp.)

5-1997 Jensen, K.-M. V., and J. B. Jespersen: Eighth Report on Semiochemicals. (11 pp.)

6-1997 Lodal, J.: Laboratorieundersøgelser med brun rotte *(Rattus norvegicus*) over palatabilitet og effektivitet af voksblokke med warfarin, bromadiolon og coumatetralyl. (16 pp.)

7-1997 Lauridsen, M. K., and J. B. Jespersen: Comparison between two azamethiphos bait formulations for control of the housefly, *Musca domestica*. (19 pp.)

8-1997 Jespersen, J. B.: Retningslinier for fluebekæmpelse på gårde med husdyr 1997. (7 pp.)

9-1997 Lodal, J.: Laboratorieforsøg med rottefælde. (49 pp.)

10-1997 Leirs, H. and J. Lodal: Mammals crossing the fixed link over Øresund: Problems and management. Preliminary considerations. (12 pp.)

11-1997 Lauridsen, M. K. and J. B. Jespersen.: Laboratory tests with CGA-X against susceptible and resistant strains of the housefly *Musca domestica*. (15 pp.)

12-1997 Larsen, K. S.: Control of artificial cat flea infestation on cats with Program VetW (lufenuron) and CGA 246'916. (22 pp.)

13-1997 Lodal, J.: Determination of acute oral LD_{50} of difenacoum against the roof rat *Rattus rattus*. (15 pp.)

14-1997 Nansen, C. and M. Kristensen: Evaluation of a *Eucalyptus globulus* based repellent against *Aedes* mosquitoes in Denmark. (14 pp.)

15-1997 Jespersen, J. B. and M. K. Lauridsen: Laboratory tests with fipronil against susceptible and resistant strains of the housefly *Musca domestica*. (14 pp.)

16-1997 Lauridsen, M. K. and J. B. Jespersen: Laboratory test with fiprole 107 382 against susceptible and resistant strains of the housefly *Musca domestica*. (14 pp.)

17-1997 Lodal, J.: Screeningsforsøg med 8 forskellige bromadiolon drikke-gifte på brun rotte (*Rattus norvegicus*). (14 pp.)

18-1997 Jensen, K.-M. V. and J. B. Jespersen: Ninth Report on Semio-chemicals. (39 pp.)

19-1997 Lodal, J.: Laboratorieforsøg med 0,01% bromadiolon drikkegift mod brun rotte (*Rattus norvegicus*). (3 pp.)

1-1998 Larsen, K. S.: Control of artificial cat flea infestations on cats with Program VetW (lufenuron) and CGA 246’916. (20 pp.)

2-1998 Carlsen, M., J. Lodal and H. Leirs: Efficacy and palatability laboratory tests with bromadiolone wax blocks for rat control. (13 pp.)

3-1998 Leirs, H. and J. Lodal: Efficacy and palatability laboratory tests with a difenacoum paste for rat control. (9 pp.)

*-1998 Dickman, C.R., H.E.L. Leirs & I. Manwan. Project review of projects “Management of rodent pests in southeast Asia” and “Management of rodent pests in Vietnam”. Australian Center for International Agricultural Research, Canberra, 43 pp.

17. Evaluation of the efficacy of pesticides

17.1 Formulations submitted for registration

According to the Danish Act on Chemical Substances and Products (No. 21 of 16 January 1996), the registration of a new pesticide formulation requires documentation of the efficacy of the formulation used according to the directions on the label and under Danish conditions. The National Agency of Environmental Protection makes decisions on registration concerned with the control of the pest in question, but the Agency sends the applications to a hearing at the national laboratories, e.g. the DPIL or the Plant Protection Centre. These institutes evaluate the efficacy and possible risks and drawbacks of using the formulation, including the potential for developing resistance and cross-resistance (see Annual Report 1982, p.102).

In 1997, pesticides submitted for evaluation and registration included formulations for control of rodents and various insects, such as houseflies and flies on cattle, fleas, ectoparasites on livestock, ants, cockroaches, storage pests, and household insects generally, as well as insects attacking wood or textiles. Several formulations were recommended for approval, but in some cases it was concluded that more documentation was needed, supplementary tests should be carried out, or it was recommended that, for certain reasons, the formulation should not be permitted for the use requested. The registration authorities generally followed our recommendations.

In 1997, the DPIL received, as usual, a steady stream of drafts of new pesticide labels submitted to the National Agency of Environmental Protection for approval. In many cases changes were suggested or required in the directions for use.

N. Bille

18. Formulations approved by the Danish Pest Infestation Laboratory as of 1 March 1998

Fortegnelse over bekæmpelsesmidler anerkendt af
Statens Skadedyrlaboratorium
1. marts 1998

Trade name	Active material	Conc.	Company

1 Formulations for fly control (Midler til bekæmpelse af fluer)

I Space sprays for indoor fly control.
(Forstøvningsmidler til udsprøjtning i luften til bekæmpelse af fluer i lukkede rum.)

(a) Solutions approved for fly control using fine atomization of at least 0.5 cm^3 per m^3.
(Opløsninger anerkendt til bekæmpelse af fluer ved fin forstøvning af mindst 0,5 cm^3 per m^3 rum.)

Trade name	Active material	Conc.	Company
DLG Staldfluedræber	bioresmethrin	0.20%	AgroDan
	piperonylbutoxyd	0.75%	
Pytoxan Fluemiddel	pyrethrin I & II	0.4%	Bayer
	piperonylbutoxyd	2.4%	
Mortalin Special 86	pyrethrin I & II	0.4%	Mortalin
	bioresmethrin	0.05%	
	piperonylbutoxyd	2.40%	

Trade name	Active material	Conc.	Company
(b) Aerosols approved for fly control when sprayed for at least 10 seconds (approx. 10 g aerosol) per 30 m^3. (Aerosoler (trykdåser) anerkendt til bekæmpelse af fluer ved sprøjtning i mindst 10 sekunder per 30 m^3 rum (svarende til ca.10 g aerosol pr 30 m^3).)			
Kill-it stald spray N	pyrethrin I & II piperonylbutoxyd	0.36% 2.16%	Bayer
(c) Aerosols approved for fly control when sprayed for at least 7 seconds (approx. 10 g aerosol per 30 m^3). (Aerosoler (trykdåser) anerkendt til bekæmpelse af fluer ved sprøjtning i mindst 7 sekunder pr. 30 m^3 rum (svarende til ca. 10 g aerosol pr. 30 m^3).)			
Mortalin Special Flueaerosol	pyrethrin I & II bioresmethrin piperonylbutoxyd	0.40% 0.05% 2.40%	Mortalin
(d) Aerosols approved for fly control when sprayed for at least 5 seconds (approx. 10 g aerosol per 30 m^3). (Aerosoler (trykdåser) anerkendt til bekæmpelse af fluer ved sprøjtning i mindst 5 sekunder pr. 30 m^3 rum (svarende til ca. 10 g aerosol pr. 30 m^3).)			
Flue Kvit*	pyrethrin I & II piperonylbutoxyd	0.40% 2.00%	Aeropak
Stald-chock flue-spray D * Norway only	pyrethrin I & II piperonylbutoxyd	0.40% 2.00%	Aeropak
Trinol Turbo jet mod fluer	pyrethrin I & II piperonylbutoxyd	0.40% 2.00%	Aeropak

Trade name	Active material	Conc.	Company
(f) Aerosols approved for fly control when sprayed for at least 6 seconds/ blue nozzle or 7 seconds/green nozzle (approx. 10 g aerosol per 30 m^3). (Aerosoler (trykdåser) anerkendt til bekæmpelse af fluer ved sprøjtning i mindst 6 sekunder med blå dyse eller 7 sekunder med grøn dyse pr. 30m^3 rum (svarende til ca. 10 g aerosol pr. 30m^3).)			
Trinol jet-	pyrethrin I & II	0.40%	Trinol
fluemiddel	piperonylbutoxyd	2.40%	
II Paint-on baits or treated strips approved for supplementary fly control in animal houses. (Smøremidler anerkendt til supplerende fluebekæmpelse i stalde.)			
Paint-on baits:			
ALFICRON plus	azamethiphos	10%	Novartis
Malure Flue-	methomyl	1.07%	Mortalin
smøremiddel	muscalure	0.04%	
Trinol smøremiddel	propetamphos	6%	AgroDan
	muscalure	0.04%	
Treated strips:		g per strip	
Malure	methomyl	0.1111	Mortalin
fluepIader	muscalure	0.0042	
III Larvicides approved for control of fly larvae. (Larvebekæmpelsesmidler anerkendt til bekæmpelse af fluelarver.)			
(a) Dosage 1 g a.i. per m². (Dosering 1 g virkstof pr. m².)			
Dimilin	diflubenzuron	25%	KVK
Trinol larvemiddel	diflubenzuron	25%	KVK

Trade name	Active material	Conc.	Company

(b) Dosage 0.5 - 1 g a.i. per m².
(Dosering 0,5 - 1 g virkstof pr. m².)

Neporex WSG 2	cyromazin	2%	Novartis
Mortalin Cyromazin mod fluelarver	cyromazin	2%	Mortalin

IV Repellents (ear tags) approved for fly control on pastured cattle when two ear tags are attached to each animal.
(Afskrækningsmidler (øremærker) anerkendt til bekæmpelse af fluer på græssende kvæg ved påsætning af to øremærker pr. dyr.)

		g per tag	
Flectron	cypermethrin	1.02	Fort Dodge

V Repellents (liquids) approved for fly control on pastured cattle.
(Afskrækningsmidler (væsker) anerkendt til bekæmpelse af fluer på græssende kvæg).

Renegade Pour-on	a-cypermethrin	1.5%	Fort Dodge
Flusa	a-cypermethrin	1.5%	Pharmacia & Upjohn
Coopersect Spot on	deltamethrin	1%	Schering Plough

Trade name	Active material	Conc.	Company

2 Formulations for control of fleas on pets and in their surroundings (Midler til bekæmpelse af lopper på kat og hund og i omgivelserne)

(a) *Approved impregnated collars to be used in combination with group (c) or (d).*
(Anerkendte, imprægnerede halsbånd anvendes kombineret med gruppe (c) eller (d).)

Bifopet utøjshalsbånd til hunde til katte	propoxur	10%	Bifopet
Lop-A' utøjshalsbånd til hunde til katte	propoxur	10%	Bifopet
Material Shop loppe-halsbånd til hunde til katte	propoxur	9.4%	Bayer

(b) *Solutions approved for control of fleas in the surroundings.*
(Sprøjtemidler anerkendt til bekæmpelse af lopper i omgivelserne.)

Gett	chlorpyrifos	0.8%	Dow Agro-Sciences
Absolut D	diazinon	2%	Bayer

(c) *Aerosols approved for preventive treatment of flea larvae in the surroundings.*
(Anerkendte aerosoler godkendt til forebyggende bekæmpelse af loppelarver i omgivelserne.)

Trade name	Active material	Conc.	Company
Pre-lop Spray	methopren	0.3%	Bayer

(d) *Pump spray approved for preventive treatment of fleas. The product acts as a flea ovicide when used on pet fur (cats or dogs).*
(Pumpespray anerkendt som forbyggende loppebehandling. Produktet forhindrer loppeæg i at klække, når katte- eller hundepels behandles.)

Anti-larve spray til katte	methopren	0.5%	Bayer
Material Shop katte-spray med methopren	methopren	0.5%	Bayer
Pre-lop til katte	methopren	0.5%	Bayer

3 Formulations for flea control on farmed mink (Midler til bekæmpelse af lopper hos farmmink)

Pulvex	permethrin	1%	Schering Plough
Safrotin 1% D	propetamphos	1%	Novartis

4 Apparatus for control of hornets (Midler til bekæmpelse af gedehamse)

Light trap for use in bakers' shops, etc.
(Lysfælde til brug i bagerforretninger, etc.)

Insect-0-Cutor	Elektrisk apparat		Tanaco

5 Apparatus for indoor mosquito control

Trade name	Active material	Conc.	Company

(Midler til indendørs bekæmpelse af myg)

Electric heater with vaporizing mats
(Elektrisk varmeplade med rygetabletter)

Kimo Myggetablet	d-trans-allethrin	0.67%	Bjørn
	(S)-d-transallethrin	3.33%	Hansen
	piperonylbutoxyd	3.00%	

6 Rodenticides for control of mice inside and around buildings (Midler til bekæmpelse af mus i og ved bygninger)

(a) Baits for general use. (Almindelige ædegifte.)

Rentokil Klerat Rotteblok	brodifacoum	0.005%	Zeneca
Brota Musekorn	bromadiolon	0.01%	Mortalin
MausEx-Duo	bromadiolon	0.01%	Trinol
Materialshop musekorn D	difenacoum	0.005%	Zeneca
Ratak musekorn	difenacoum	0.005%	Zeneca
Trinol Musekorn	bromadiolon	0.01%	Trinol

(b) Bait for control of mice in or around buildings at temperatures below 16°C. (Ædegift til bekæmpelse af mus i og ved bygninger ved temperaturer under 16°C.)

Alta Musepulver	chloralose	4.0%	Mortalin

7 Formulations for control of the water vole (*Arvicola terrestris*)

Trade name	Active material	Conc.	Company

(Midler til bekæmpelse af mosegrise)

Bromadiolone concentrate for the impregnation of fresh apple slices used for control of water voles. (Bromadiolon-koncentrat til fremstilling af bromadiolon-æbler mod mosegrise.)

Bromadiolon Koncentrat	bromadiolon	0.25%	Mortalin

8 Rodenticides for control of rats (*Rattus norvegicus* and *R. rattus*) (Midler til bekæmpelse af rotter)

The following 35 products were approved by the Danish Pest Infestation Laboratory as of 1 March 1997. A list of the various products is published by the Ministry of the Environment. It may be obtained from the following addresses: Torben F. Jensen, Miljøstyrelsens Konsulent i Rottebekæmpelse for Jylland, Langdalsvej 38C, 8220 Brabrand, or Peter Weile, Miljøstyrelsens Konsulent i Rottebekæmpelse for Øerne, Strandgade 29, 1401 København K.

(Følgende 35 produkter var pr. 1. marts 1997 anerkendt af Statens Skadedyrlaboratorium. En liste omfattende de forskellige produkter er udgivet af Miljøstyrelsen. Listen kan erhverves ved henvendelse til følgende adresser: Torben F. Jensen, Miljøstyrelsens Konsulent i Rottebekæmpelse for Jylland, Langdalsvej 38C, 8220 Brabrand, eller Peter Weile, Miljøstyrelsens Konsulent i Rottebekæmpelse for Øerne, Strandgade 29, 1401 København K)

Hydroxycoumarines:

Baits (0.0025-0.01%)	*16 preparations*
Tracking powders (0.15%)	*3 preparations*
Solutions (0.01%)	*1 preparation*
Paraffin blocks (0.0025-0.01%)	*13 preparations*
Concentrate (0.25%) for fresh apple	*2 preparations*

9 Formulations for control of the mole

Trade name	Active material	Conc.	Company

(*Talpa europaea*)
(Midler til bekæmpelse af muldvarpe)

Pellets containing 56-57% aluminium phosphide are approved for the control of moles. Restricted use.
(Pellets med et indhold af 56-57% aluminiumphosphid er anerkendt til bekæmpelse af muldvarpe. Kan kun anvendes af personer, der har fået en særlig tilladelse.)

10 Traps for control of rodents
(Fælder til bekæmpelse af gnavere)

Trade name	Active material	Conc.	Company
RM Mosegrisefælden	Water vole trap		RM-Service

11 Device to prevent sewer rats entering buildings via waste pipes
(Aggregat til forhindring af kloakrotters indtrængning i bygninger via faldstammer)

Trade name	Active material	Conc.	Company
Rottestop	Steel section to be inserted into ordinary waste pipe		SR-Stål

List of companies
Firmafortegnelse

Company Firma	Address Hjemsted	Abbreviation used in chapter 18 Forkortelse anvendt i kapitel 18
Aeropak A/S	Hedensted	Aeropak
AgroDan A/S	Esbjerg	AgroDan
Bayer A/S	Lyngby	Bayer
Bifopet Product Aps	Lynge	Bifopet
Dow AgroSciences Danmark A/S	Lyngby	Dow AgroSciences
Fort Dodge Animal Health	Belgien	Fort Dodge
Hansen, Bjørn	Hellerup	Bjørn Hansen
KVK Agro A/S	Køge	KVK
Medimerc A/S	Tåstrup	Medimerc
A/S Mortalin	Haslev	Mortalin
Novartis Agri A/S	København Ø	Novartis
Pharmacia & Upjohn Animal Health	København K	Pharmacia & Upjohn
RM-Service/v. Herluf Rosing	Brønderslev	RM-Service
Schering Plough Animal Health A/S	Farum	Schering Plough
SR-Stål A/S	Søborg	SR-Stål
Tanaco Danmark A/S	Esbjerg	Tanaco
Trinol A/S	Ålborg	Trinol
Zeneca Agro	København S	Zeneca