The Danish Pest Infestation Laboratory conducts research and experimental tests while accumulating knowledge on insect, mite, and rodent 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, and environmental impacts of pesticides.

In addition, 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.

Statens Skadedyrlaboratorium, Årsberetning 1998
Danish Pest Infestation Laboratory, Annual Report 1998
Lyngby, 1999, 110 pp.
Editors: N. Bille and M. Christensen
Drawings©: K.-M. V. Jensen
ISSN: 0374-504X
Printing: Frederiksberg Bogtrykkeri
Price: DKK 100.- + moms

Danish Pest Infestation Laboratory Annual Report 1998

Indhold Side

Contents Page

Forord

Det er mig en glæde at præsentere laboratoriets årsberetning 1998.

Laboratoriets økonomi er for tiden rimeligt god med en hensigtsmæssig fordeling mellem basisbevilling og eksternt finansierede aktiviteter. Laboratoriet vil tilstræbe, at denne fordeling fastholdes, fordi det giver en fin balance mellem strategisk forskning og mere anvendelsesorienteret forskning. For de kommende år tegner økonomien sig imidlertid ikke særligt lovende. Et par store forskningsprojekter ophører, og det har på nuværende tidspunkt ikke været muligt at finde erstatning for dem. Det er derfor mit håb, at der meget snart vil vise sig muligheder for at søge på relevante forskningsprogrammer, der kan videreføre noget af den forskning, der i de senere år har givet meget lovende resultater.

Projekterne vedrørende forskning i biologisk og mikrobiologisk bekæmpelse og biokemiske mekanismer bag pesticidresistens løber ud ultimo 1999. 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.

Yderligere to projekter vedrørende pattedyrforskning er påbegyndt med en Ph.D.-studerende knyttet til hver. Laboratoriet vil prioritere forskeruddannelse højt og tilstræbe, at fremtidige projekter giver mulighed for tilknytning af Ph.D.-studerende.

Den store begivenhed i 1998 var festligholdelsen af laboratoriets 50 års jubilæum. Alle laboratoriets medarbejdere havde gjort et stort arbejde for, at jubilæumsdagen kunne blive så interessant og festlig som muligt. I forbindelse med arrangementet var der arrangeret en udstilling, hvor en masse af laboratoriets gamle PR-materiale blev anvendt. Foruden en række tableauer, var en masse gamle plakater og tegninger udstillet. Laboratoriet råder over mange tegninger af R. Storm-Petersen, som tidligere har været anvendt til kampagner for kornskadedyrs- og rottebekæmpelse. Nogle af tegningerne vil være kendt fra laboratoriets julekort, hvor vi også anvender dem. Jubilæumsdagen blev en virkelig succes. Der var et stort fremmøde af inviterede gæster, som viste stor interesse for udstillingen.

I mange år har årsberetningens forord været præget af beklagelser over de meget begrænsede pladsforhold. Det er endelig lykkedes at finde en løsning på dette problem, idet der på finansloven for 1999 bliver bevilget et betydeligt beløb til udvidelse og ombygning. Omfanget er ca. 1200 m^2 nybyggeri og ca. 800 m^2 ombygning af de nedslidte faciliteter. Planerne er, at 1999 anvendes til projektering, og 2000-2002 bliver byggeperiode. Projektet forventes færdigt i første halvår af 2002. Planerne er at gennemføre byggeriet i etaper, således at aktivitetsniveauet på forskningssiden kan opretholdes. Laboratoriet ser med stor forventning frem til at kunne tage de nye faciliteter i brug og betragter det som den bedst tænkelige jubilæumsgave.

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 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 1998 i internationale konferencer eller kongresser i Schweiz, England, Filippinerne, Belgien, Spanien, Lithauen, Sverige, Grækenland, Kina, Portugal og Italien.

Arbejde for WHO. SSL er "WHO collaborating Centre on Pesticide Resistance". J. B.Jespersen har siden 1991 været medlem af "WHO Expert Panel of Vector Biology and Control" og deltog i 1998 i to møder hos WHO i Geneve.

Arbejde for FAO. J. B. Jespersen blev i 1998 medlem af et ekspertudvalg i FAO benævnt "Panel of Experts on Resistance in Livestock" og deltog i et møde i Rom.

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.

I 1996 opnåedes støtte til en Concerted Action (ENMARIA) 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.

I 1998 blev J. B. Jespersen medlem af en Cost Action om "Mange and Myiasis in Livestock in Europe" og deltog i 1998 i flere møder i denne forbindelse.

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

Undervisning

Adskillige af laboratoriets medarbejdere har holdt forelæsninger for studerende, medvirket som vejledere for speciale- og Ph.D.-studerende samt fungeret som censorer ved universiteterne.

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

Konsultationen

Bemærkelsesværdige enkeltsager og karakteristiske variationer i antallet af henvendelser i 1998

Tofarvet frømøl, *Plodia interpunctella*, blev også dette år registreret i et større antal end nogensinde før. I september og oktober 1997 var antallet af forespørgsler om denne art meget højt sammenlignet med de foregående år. Den høje forekomst gav anledning til usædvanligt mange forespørgsler i foråret 1998, mens der var færre henvendelser end normalt i efteråret. Det høje antal af tofarvede frømøl i foråret kan skyldes, at arten har haft meget gode betingelser i august og september 1997, der var varmere end normalt.

I sommermånederne blev **murerbier, *Osmia spp.*** registreret i så stort et antal, at det ikke er set siden 1993. Henvendelserne kom ofte fra bekymrede personer, der var overbevist om, at det drejede sig om murbier (*Colletes daviesanus)*, der var i færd med at ødelægge deres hus. I de tilfælde, hvor der blev indsendt eksemplarer af bierne, viste det sig oftest, at der var tale om helt uskadelige murerbier.

Pragtbille, *Buprestis aurulenta*, blev fundet i tagkonstruktionen på et 10 år gammelt hus i Jylland. Taget var åbnet på grund af reparation, og et levende eksemplar af pragtbillen og spor efter larvens aktivitet blev fundet i tømmeret. *Buprestis aurulenta* ses meget sjældent i Danmark og hører naturligt hjemme i Nordamerika. Den er sandsynligvis blevet ført til Danmark med det tømmer, der er anvendt til opførelsen af huset. I naturen lever larverne i syge og døende træer i skoven, og larvetiden kan forlænges op til 25 år, hvis det træ, som larven lever i, anvendes til bygninger og dermed udtørrer. I Danmark vil denne art sandsynligvis aldrig kunne udvikle sig til at blive et alvorligt træskadedyr.

Der har i 1998 været mange henvendelser om den **iberiske skovsnegl** ("dræbersneglen"), ***Arion lusitanicus*****,** fra bekymrede personer, der mente, at de havde set denne snegl i deres have, hvor den kan være et alvorligt skadedyr. I løbet af sommeren blev den iberiske skovsnegl registreret i mange egne af Danmark og har flere steder optrådt i et meget stort antal. I private haver kan bekæmpelse ske ved indsamling og aflivning af sneglene med kogende vand.

I efteråret var der mange forespøgelser om **tusindben,** ***Diplopoda***, som flere steder blev set kravlende langs med husmurene eller op ad disse i et meget stort antal. En del berettede, at selvom de indsamlede dem i spandevis, var der stadig lige mange. De meget våde sommer- og efterårsmåneder i 1998 har sandsynligvis givet gode betingelser for tusindben, der lever på fugtige steder. Om efteråret kan disse dyr samle sig og "gå på vandring" efter egnede overvintringssteder, hvilket kan forklare deres masseoptræden. Selvom tusindben for nogle var en ubehagelig oplevelse, gør de ingen skade på hverken mennesker eller bygninger.

Hovedlus, ***Pediculus capitis,*** blev igen i år registreret i et højere antal end nogensinde før. Der er stadig mange problemer med hovedlus, især på skoler og i børnehaver.

I de sidste tre år har antallet af henvendelser om **kattelopper,** ***Ctenocephalides felis*****,** været faldende. Det kan skyldes et stigende forbrug af forebyggende midler mod kattelopper, og at katte- og hundeejere finder de mange nye produkter på markedet nemme at bruge.

Undersøgelser og afprøvninger

Insektafdelingen

Laboratoriets samling af fluestammer udgjorde ved årets udgang 21 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 tætheder være yderst generende over for husdyr og mennesker. Fluerne kan ligeledes overføre forskellige sygdomme og ved deres generende adfærd nedsætte husdyrenes tilvækst og mælkeydelsen i kvægbesætninger.

Som led i en undersøgelse af mulighederne for alternative eller supplerende metoder til brugen af insecticider har Fødevareministeriet på tredje år støttet et projekt med henblik på anvendelse af snyltehvepse til bekæmpelse af stue- og stikfluer i grise- og kvægbesætninger i Danmark. De to foregående år er anvendt på at beskrive artssammensætningen af snyltehvepse, der forefindes på udvalgte gårde, og deres sæsonmæssige aktivitet (se SSL’s årsrapport 1997). Dette arbejde har ført til indkredsning af to potentielle arter af snyltehvepse, *Spalangia cameroni* og *Muscidifurax raptor*, der begge er almindelige og dominerende på de fleste gårde.

Dette tredje år er anvendt til at studere spredningsaktivitet af udsatte snyltehvepse i et staldmiljø. De foreløbige resultater har vist, at den undersøgte art, *S. cameroni*, inden for første døgn efter udsætning kun spreder sig få meter fra udsætningsstedet. Dette resultat betyder, at når *S. cameroni* anvendes til kontrol af stue- og stikfluer, bør udsætningen foregå mange steder i staldmiljøet. Kendes de steder, hvor fluerne opformeres, kan udsætningen selvfølgelig koncentreres til disse steder i stalden. Spredningsundersøgelserne skal videreføres i 1999 med inddragelse af *M. raptor*, der i de tidligere undersøgelser har vist sig at være betydeligt aggressiv over for fluepuparier. Ligeledes skal spredningsaktiviteten af hvepsene undersøges gennem flere dage for at studere, om dette medfører en ændring i spredningsmønsteret.

Entomophthora muscae sensu lato. Når stuefluer *Musca domestica* smittes med de insektpatogene svampe *Entomophthora muscae* eller *E. schizophorae*, kan de kurere sig selv, hvis de tidligt i inkubationsforløbet (1-3 dage efter smittepåførsel) opsøger varme overflader - de siges at opnå “behavioural fever”. Senere i inkubationsforløbet, kort tid før fluerne dør af svamp, opsøger de derimod kølige overflader. Det gør de muligvis for at beskytte patogenet, der på dette tidspunkt kan have overtaget styringen.

Der blev udført to forsøg i august/september 1998 i samarbejde med professor Bradley A. Mullens, Department of Entomology, University of California, Riverside, med det formål at afklare nogle af mekanismerne bag "behavioural fever" under naturlige forhold i Danmark.

1) På en økologisk gård med kvæg med et åbent driftssystem og en naturlig forekomst af *E. muscae* blev der ketsjet fluer indendørs fra kølige overflader og udenfor fra solopvarmede overflader. Der blev samlet fluer flere gange om dagen gennem 4 dage. Fluerne blev sat op enkeltvis, og tidspunktet for død/sporulering blev noteret. Da inkubationstiden for *E. muscae* er ret konstant ved en given temperatur, må fluer, der døde af *E. muscae* kort tid efter fangst, have været langt inde i inkubationsforløbet og omvendt.

De foreløbige resultater viser, at en større procentdel smittede fluer blev fundet indendørs (38%) end udendørs, hvor der var 27% smittede fluer på relativt varme mørke overflader og 15% smittede fluer på noget foder. Endvidere var der en tendens til, at flere fluer fanget indendørs døde hurtigt efter fangst dvs. længere inde i inkubationsforløbet.

2) For at se om inficerede fluer opnår "behavioural fever", blev ca. 3.000 fluer inokuleret med *E. schizophorae* (mærket med gul farve) og ca. 3.000 kontrolfluer (mærket med blå farve) sluppet ud i en lukket farestald med varmelamper på over 40°C. Fluerne var afkom af indfangede vilde fluer for at imødegå de adfærdsændringer, der kan forekomme hos fluestammer, der har været i opdræt længe. Fluerne blev udsat på andendagen efter inokulering og derefter observeret på flere slags overflader med forskellige temperaturer inkl. varmelamperne hver anden time fra kl. 8 til 18 i 6 dage. Især på udsættelsesdagen var det totale antal inokulerede fluer på varmelamperne højere end antallet af kontrolfluer, hvilket sammen med følgende andre faktorer kan være udtryk for, at fluerne opnåede "behavioural fever": Procenten af inficerede fluer faldt fra 30% til 5% efter 2 dage og til 0% efter 4 dage efter udsætning. Intet markant antal inokulerede fluer blev fundet på kølige overflader senere i inkubationsforløbet, hvor de formodes at beskytte patogenet, og kun et gult kadaver blev fundet efter en grundig gennemgang af stalden.

Hyphomyceter til fluebekæmpelse i stalde. Svampe fra klassen *Hyphomycetes* har i modsætning til *E. muscae* bekæmpelsespotentiale også over for stikfluen *Stomoxys calcitrans*. I starten af projektet blev den naturlige forekomst undersøgt af disse svampe i stuefluer og stikfluer indsamlet fra en lang række stalde. Fra stuefluer blev isoleret *Beauveria bassiana*, *Metarhizium anisopliae*, *Paecilomyces fumosoroseus*, *Verticillium lecanii* og *Verticillium fusisporum*. Fra stikfluer blev isoleret *B. bassiana* og *V. lecanii*. Prævalensen var i alle tilfælde lav (under 5%). I modsætning til *E. muscae* forekommer disse svampe tilsyneladende ikke epidemisk i danske staldsystemer. Svampene blev isoleret *in vitro* og undersøges fremover i smitteforsøg med de to fluearter for at finde de mest velegnede isolater til fluebekæmpelse.

Stuefluer indgik sammen med bomuldsmellusen *Bemisia tabaci* i en undersøgelse af, hvorvidt en række arter af *Verticillium* og *Acremonium* er insektpatogene. *Verticillium fusisporum* isoleret fra stuefluer viste sig ikke at være infektiv over for stuefluer og må betragtes som en saprofyt. Andre isolater af denne svampeart viste sig dog at være meget virulente over for bomuldsmellus. Adskillige arter af *Verticillium* og *Acremonium* forårsagede høj mortalitet i stuefluer. Eftersom hovedparten af de angrebne fluer først døde efter ca. 14 dage, har ingen af de undersøgte svampe dog potentiale som fluebekæmpelsesmidler. Forsøg med andre hyphomyceter har derimod givet lovende resultater.

Mikrobiologisk bekæmpelse af fluer på græssende kreaturer. I projektet undersøgtes den naturlige forekomst af insektpatogene svampe i forskellige fluearter tilknyttet græssende kreaturer. Svampenes potentiale som bekæmpelsesmidler blev evalueret. Der blev ketsjet fluer på kvier i Store og Lille Vildmose én gang ugentligt i perioden fra midten af juli til midten af september. Desuden blev der suppleret med lejlighedsvise indsamlinger fra andre lokaliteter. Som i 1997 var forekomsten af svampe meget lav. Imidlertid blev der i 1998 ikke kun fundet svampe fra Hyphomycetes, men tillige arter af Entomophthorales (Entomophthora muscae, Furia sp.). Forsøg på overførsel af *E. muscae* fra stuefluer til forskellige fluer fra græssende kreaturer og *vice versa* tyder på, at de forskellige isolater af svampen er meget værtsspecifikke. Det kan også forklare den lave svampeprævalens i kreaturfluer trods tilstedeværelsen af *E. muscae* epidemier i bl.a gul gødningsflue på begge indsamlings-lokaliteter. I den resterende del af projektet fokuseres der på smitteforsøg med svampe fra Hyphomycetes.

Svampe til bekæmpelse af tyske kakerlakker. Projektet, som blev indledt i 1996, blev afsluttet ved årets udgang. I 1998 blev der fokuseret på spredning af udvalgte insektdræbende svampe i kakerlakbestande samt på fugtighedens betydning for infektion af kakerlakker. Forsøg med tilførsel af svampesporer til kakerlakkers vandforsyning viste, at det er muligt at overføre smitte med *Paecilomyces fumosoroseus* og *Metarhizium anisopliae* på denne vis. Det var dog kun få kakerlakker, der blev inficeret, og det vides ikke, hvorvidt kakerlakkerne kan detektere svampene og derfor vil søge at undgå dem, såfremt de kan vælge drikkevand, der ikke er behandlet med svampe. En række spredningsforsøg udført med henholdsvis levende, men smittede kakerlakker og med sporulerende kadavere anbragt i kakerlakkernes skjulesteder viste, at det er muligt at sprede *M. anisopliae* i en kakerlakbestand. Dødeligheden i disse spredningsforsøg nåede dog ikke op på den dødelighed, der tidligere er opnået i andre smitteforsøg. *P. fumosoroseus* var helt ineffektiv i spredningsforsøgene.

Tidligere smitteforsøg blev gennemført ved meget høj luftfugtighed (% RH) for at øge svampenes effekt. Fugtigheden i kakerlakkernes naturlige miljø er imidlertid ikke altid særligt gunstig for spiring og sporulering af svampe, der angriber insekter. Vore undersøgelser viste, at den bedste virkning af svampene blev opnået ved 100% RH i det første døgn efter behandling. En RH på 85% virkede begrænsende på infektionen, men det var dog stadig muligt at inficere kakerlakker under disse betingelser.

Hovedlus. De sidste års stigende problemer med hovedlus blandt børn på skoler og i daginstitutioner medførte, at Statens Skadedyrlaboratorium i efteråret 1998 tog initiativ til en spørgeskemaundersøgelse om hovedlus i Danmark. Undersøgelsen er rettet mod apotekerne, den kommunale sundhedspleje og forældre til børn på skoler og i daginstitutioner. Formålet med undersøgelsen er at belyse, hvor udbredt problemet med hovedlus er, hvem det er, der får hovedlus, hvordan lusemidlerne vurderes af forbrugerne, og hvordan informationsniveauet og informationsvejene omkring hovedlus er.

Alle landets apoteker og kommunale sundhedsplejer har modtaget spørgeskemaer, og forældre til børn på udvalgte skoler og daginstitutioner i København og Silkeborg er blevet bedt om at deltage i undersøgelsen. I alt er der blevet uddelt 2.020 spørgeskemaer.

Spørgeskemaundersøgelsen om hovedlus er den hidtil mest omfattende undersøgelse i Danmark og forventes afsluttet i løbet af 1999. Undersøgelsen støttes økonomisk af et privat firma.

Kyllingemiders reaktion på værtsstimuli under forskellige lysforhold. Kyllingemider fra vores laboratoriekultur blev anbragt på små platforme uden mulighed for at tage føde til sig i mindst fire dage før forsøgene.

Derefter blev de stimuleret med vibrationer og CO_2 under forskellige lysintensiteter. De foreløbige resultater har vist, at vibrationer ved 2 kHz er mest effektive til at aktivere miderne, samt at responset på vibrationer og CO_2 er meget afhængigt af lysintensiteten. Ved lav lysintensitet (3 lux) aktiverer begge stimuli miderne, og der ses en synergistisk effekt ved kombineret stimulering. Ved høj lysintensitet (80 lux) aktiveres miderne fortsat af vibrationer, men de reagerer på CO_2 med en "fryse"-respons: de stopper op og bliver stående uden at bevæge sig. Hvis sådanne mider efterfølgende stimuleres med vibrationer, aktiveres de under vibrationerne, men stopper øjeblikkeligt op igen, når vibrationerne stopper. Denne adfærd tolkes som en måde at undgå at blive ædt af den potentielle vært på, idet CO_2 indikerer, at værtens opmærksomhed er rettet mod miden, hvorimod vibrationerne indikerer, at værten bevæger sig, og derfor at det er relativt sikkert for miden at søge videre.

Betydningen af parasitter for æglæggende høners adfærd og sundhed. For at undersøge, hvordan endo- og ektoparasitter påvirker æglæggende høners adfærd og sundhed, blev der i samarbejde med Den Kgl. Veterinær- og Landbohøjskole oprettet 6 forsøgsgrupper på hver 15 høner. To grupper blev inficeret med den endoparasitære nematode, *Ascaridia galli,* og to grupper med ektoparasitten, *Dermanyssus gallinae* (kyllingemiden), og endelig blev to uinficerede grupper holdt som kontrol.

Resultaterne viste, at ved kraftige infestationer af kyllingemider lider hønerne af udtalt anæmi som følge af blodtabet, og de kompenserer ved at øge produktionen af erythrocytter. I tilfælde af særligt voldsomme mide-infestationer ses endog øget mortalitet. Derudover ses reduceret vækst og adfærdsændringer, idet hønerne bruger signifikant mere tid både dag og nat på at pudse fjerene på grund af de mange mider, som kravler på huden og fjerene. Resultaterne viste tydeligt, at det er vigtigt for hønernes sundhed og velfærd at undgå voldsomme angreb af kyllingemider.

Insektpatogene svampe til bekæmpelse af melbiller i fjerkræstalde. Projektet, som blev indledt i 1996, blev afsluttet ved årets udgang. Der foreligger ved projektets afslutning en række svampeisolater, der i laboratoriescreeninger har vist sig effektive over for henholdsvis larver og voksne melbiller. Planlagte forsøg på at applikere svamp til lille melbille ved placering i en bait-station blev ikke gennemført, da indledende burforsøg viste, at det var meget vanskeligt at tiltrække larver og voksne til disse infektionskamre under realistiske forhold, dvs. at kamrene var placeret i et substrat, der gav insekterne mulighed for at gemme sig. I løbet af et døgn søgte kun 5-10% af larverne ind i disse infektionskamre, og forsøgene tydede desuden på, at disse larver blev tiltrukket af kamrenes mørke frem for deres indhold af foder. Inden metoden opgives, bør det imidlertid undersøges, hvorvidt svampene i praksis kan spredes i melbillepopulationer i strøelse eller gødning, når 5-10% af larverne er inokuleret med svamp, ligesom andre bait-typer bør undersøges.

Mitters virkning på græssende kreaturer blev undersøgt i et samarbejdsprojekt mellem Statens Veterinære Serumlaboratorium, Roskilde Universitets Center og Statens Skadedyrlaboratorium. To grupper på 5 kvier hver blev behandlet med insekticid, to grupper også på hver 5 dyr blev derimod ikke behandlet. De fire grupper græssede alle tæt ved en mose, der er kendt for at huse et stort antal mitter. En femte gruppe på 5 dyr græssede et stykke derfra på en græsgang, hvor der ikke forekom mitter. Dyrene blev fulgt ved vejning samt blod- og fæces-prøvning igennem hele græsningssæsonen 1998. Ved slagtningen i oktober blev dyrene inspiceret for patologiske forandringer, og der blev udtaget prøver til histopatologi.

Lysfælder blev anvendt til at bestemme mængde og artssammensætning af mitter i området. Det kunne konstateres, at mittebelastningen var meget lav i sommeren 1998 (5-10 gange lavere end de foregående år).

Det konkluderedes, at der ikke kunne findes nogen effekt af insekt-bekæmpelsen på dyrenes tilvækst. Ligeledes kunne ingen af de påviselige forandringer eller forskelle mellem grupperne af forsøgsdyr skyldes påvirkning af mitter.

Fluer på græssende kreaturer har indgået i et EU-projekt i de foregående år, og resultatet af undersøgelserne blev præsenteret ved ”9th International Congress on Pesticide Chemistry (London 2-7 august 1998)”. Det overordnede mål med undersøgelserne var at finde nye måder at bekæmpe insekterne på, idet der er sket en resistensudvikling mod de allerede kendte insekticider, og samtidig er der en generel bekymring for, hvad der kan ske i forbindelse med bekæmpelse med insekticider. Alternativer i form af tiltrækkende og afskrækkende duftstoffer blev derfor undersøgt. Det blev påvist i undersøgelsen, at der er meget store individuelle forskelle mellem de enkelte kvier, med hensyn til hvor mange fluer de tiltrækker; nogle har praktisk talt ingen fluer på sig, mens andre kan have flere hundrede. For at vise, at det er muligt at manipulere fluebelastningen i en kvieflok, blev kvier med mange eller få fluer byttet ud og ind i flokkene. Det kunne vises, at det er muligt at ændre antallet af fluer i en flok, alt efter om man har gode fluetiltrækkende kvier i flokken, eller om man har kvier, der naturligt skræmmer fluerne væk. Duftstoffer, der blev frigivet fra henholdsvis fluetiltrækkende og flueafskrækkende kvier blev indsamlet ved hjælp af teknikker, hvor molekyler i en luftstrøm fanges i et filter. Der blev isoleret 18 stoffer, hvoraf 1-octen-3-ol og m-/p-cresol tidligere har vist sig at kunne påvirke fluers værtssøgning. Et af de nye stoffer, der blev identificeret var 6-methyl-5-hepten-2-one. Dette stof udviste en tydelig effekt på fluer i laboratoriet, og ved en lille eksperimentel afprøvning i felten kunne det vises, at stoffet foranledigede, at fluerne i kvieflokken fordelte sig på en helt ny måde

IPM i industrimøller. Brugen af methylbromid blev omfattet af et totalforbud i Danmark pr. 1. januar 1998, og møllerierne måtte derfor basere bekæmpelsen af insektskadedyr på en kombination af andre kemiske og alternative bekæmpelsesmetoder. Denne samordning af bekæmpelses- og forebyggelsesmetoder betegnes som IPM. Møllerne har primært håndteret forbudet mod methylbromid gennem en forøget hygiejneindsats. Ved hjælp af regelmæssige nedlukninger af produktionen kombineret med rengøring inden i maskineriet har møllerne i stor udstrækning formået at undvære methylbromid. Projektet, der er et samarbejdsprojekt mellem Statens Skadedyrlaboratorium, møllerierne og et desinfektørfirma redegør for, hvilke muligheder der er for at foretage yderligere forbedringer i de aktuelle IPM systemer.

IPM i skandinaviske melmøller. I dette projekt indgår en dansk og en norsk melmølle. Begge møller er store industrimøller, der håndterer mere end 100.000 tons korn om året. Situationen i Danmark og Norge blev sammenlignet med hensyn til klima, bygninger, hygiejnekrav, bekæmpelsesprocedurer m.v.. Situationen i de to lande var meget ens, med den undtagelse at man i Norge stadig benytter sig af gasninger med methylbromid. Begge møller benytter sig af IPM-systemer, og undersøgelsen giver en række anbefalinger til forbedringer af disse integrerede bekæmpelsessystemer.

Skadedyrallergener i korn og kornprodukter. Dette projekt er afsluttet med godkendelsen af C. Danielsens Ph.D.-afhandling "Population dynamics of *Lepidoglyphus destructor* (Schrank) (Acarina: Glycyphagidae) and its production of allergens in stored grain".

Biologisk bekæmpelse af melmøl i møllerier. Det forløbne år var tredje år af det femårige projekt, hvis formål er at opstille strategier for anvendelse af nyttedyr (snyltehvepse eller rovmider) mod melmøl i møllerier.

Kortlægningen af klima og melmølbestandene i to industrimøller er fortsat i yderligere et år, og programmet er udvidet til at omfatte en mølle, der forarbejder økologisk dyrket korn. Data vil blive anvendt til at belyse de faktorer, der betinger den store stigning i antallet af melmøl, der er observeret i foråret.

Der er gennemført laboratorieundersøgelser af de to nyttedyrarter, der er udvalgt til formålet. Udviklingstiden fra æg til voksen er blevet bestemt ved temperaturerne 15°, 20°, 25° og 30°C hos *Trichogramma evanescens*, en snyltehveps. Varigheden spændte fra 33 dage ved 15°C til 7 dage ved 30°C. Den nedre temperaturgrænse for gangaktivitet hos hun-snyltehvepse lå mellem 7° og 13°C; gennemsnittet var 10°C. Undersøgelser af snyltehvepsens fekunditet og levetid er påbegyndt og fortsætter i 1999.

Forsøgene med rovmiden *Blattisocius tarsalis* er fortsat i 1998. Der blev gennemført laboratorieforsøg til belysning af prædationsratens afhængighed af temperatur og byttedyrstæthed. Der er igangsat forsøg til en nærmere undersøgelse af udviklingstid og fekunditet.

Laboratorieundersøgelserne af temperaturens indflydelse på fangster af melmøl-hanner i feromonfælder er afsluttet. Fangstandelen varierede mellem 1% og 47% ved temperaturer mellem 12.5°C og 30°C; den var højest ved 20°C.

Effekten af lav iltkoncentration på museumsskadedyr. Der er gennemført screeningsundersøgelser af effekten af 0,3% ilt på 7 forskellige museumsskadedyr, fortrinsvis klannere (Dermestidae); eksponeringstider: 6 til 72 timer. *Attagenus smirnovi* æg var de mest følsomme (ingen overlevende), mens *Att. woodroffei* larver overlevede 72 timers behandling.

Lagerskadedyr i majs i Afrika. I 1998 er der startet et nyt Ph.D.-projekt, som har til formål at belyse visse aspekter af biologien hos et tropisk lagerskadedyr, the larger grain borer (*Prostephanus truncatus*). Denne bille er indført fra Mellemamerika og har bredt sig som et skadedyr i mange afrikanske lande, hvor den angriber lagre af bl.a. majs og kassava. Billen lever også i træ, men man har meget begrænset viden om dens levevis uden for lagringssæsonen. Projektet har basis hos IITA i Benin og skal analysere billens forekomst i skove i forhold til vegetationsanalyser og klimaforhold. Der vil desuden blive arbejdet med billens symbiose med intracellulære mikroorganismer, som medvirker ved nedbrydningen af træ.

Pattedyrafdelingen

En bromadiolon drikkegiftformulering viste sig ikke at blive tilstrækkeligt godt accepteret af brune rotter til brug for bekæmpelse.

Alphachloralose pasta blev i en forsøgsserie fundet egnet til musebekæmpelse.

Resistensundersøgelserne med den brune rotte omfattede omkring 1.000 indsendte rotter. Der blev fundet resistens mod coumatetralyl i en ny kommune og også mod difenacoum i en ny kommune, og begge kommuner er beliggende på Sjælland.

Populationseffekter af resistens hos brune rotter undersøges i laboratoriekulturer, der bliver udsat for forskellige selektionstryk med bromadiolon. Dette projekt er et nystartet Ph.D.-projekt.

Prædatortrykkets betydning for markmus blev undersøgt i feltforsøg og resulterede i en Ph.D.-afhandling. Resultaterne viser højere overlevelse, mere positiv vægtudvikling, tidligere reproduktion og højere bestandtæthed på netoverdækkede arealer, der giver afskærmning mod prædatorer, end på arealer med uhindret prædatoradgang. Lignende resultater blev fundet for rødmus og spidsmus.

Markmusens adfærd under prædationstryk fra brud, *Mustela nivalis*, blev undersøgt i laboratoriet. Markmus, der er konfronteret med lugt fra en bruds ekskrementer, var mindre aktive og spiste mindre høj-præferencefoder langt fra reden, end når de blev udsat for en neutral lugt eller i kontrolsituationer.

Populationsdynamik hos den afrikanske rotte, *Mastomys*, blev undersøgt ved hjælp af data, som blev indsamlet i Tanzania. En populationsmodel blev videreudviklet for at forudsige rotteudbrud og simulere bekæmpelsesmetoder. Betydningen af prædatortrykket og andre faktorer som f.eks. vegetationsmønster for populationsudviklingen hos *Mastomys* bliver fortsat undersøgt i feltforsøg og danner basis for to Ph.D.-projekter.

En kombination af bromadiolon og fipronil var effektiv til samtidig bekæmpelse af husrotter og deres lopper i laboratorieforsøg. Dog skal lokkemadens palatabilitet for rotterne forbedres med henblik på praktisk anvendelse.

Et projekt om græsningseffekter på små pattedyr i lavbundsarealer blev igangsat.

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

I afsnit 15 kan man finde medarbejdernes publikationer og forsøgs-rapporter udarbejdet i 1998 og første halvdel af 1999.

I afsnit 17 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 1998 Annual Report.

At present the financial circumstances of the Danish Pest Infestation Laboratory are reasonably good with an appropriate division between the basic grant and externally financed activities. The laboratory will endeavour to maintain this division as it gives a fine balance between strategic research and a more user-oriented research. However, the financial circumstances do not seem promising for the years to come. A couple of big research projects will expire, and at the present time it has not been possible to find replacements. Therefore, it is my hope that possibilities of applying for relevant research programmes will turn up soon that could carry on some of the research which has resulted in very promising findings during recent years.

The projects concerning research in biological and microbiological control and biochemical mechanisms underlying pesticide resistance expire at the end of 1999. Both programmes are carried out in collaboration with the Royal Veterinary and Agricultural University and the Danish Institute of Agricultural Services; the resistence research in collaboration with the Rokilde University as well. Ph.D. education is attached to both programmes.

Two projects concerning mammal research have been commenced, each with a Ph.D. student attached. The laboratory gives high priority to research education and intends to include provision for Ph.D. students in future projects.

The event of the year was the celebration of the laboratory's 50th anniversary. The whole staff spared no effort in order to make the day of jubilee as interesting and festive as possible. In connection with the celebration an exhibition had been established, in which a great deal of the old PR material of the laboratory was used. Besides a number of tableaus, a number of old posters and drawings were on display. The Danish Pest Infestation Laboratory possesses many sketches by Robert Storm-Petersen which have been used in campaigns for the control of stored product pests and rats. Some of these sketches may be familiar as the laboratory makes use of them on its Christmas cards. The jubilee celebration was a great success. Many of the invited guests were able to attend and took great interest in the exhibiton.

For many years complaints concerning the very limited working space of our laboratory have been expressed in the introduction of the Annual Report. A solution to this problem has finally been found as the Appropriation Act for 1999 contains a considerable appropriation for an extension and a conversion of the laboratory. The extent of this project is approx. 1200 m^2 of new building and approx. 800 m^2 of rebuilding of the existing facilities. Detailed planning and contracting will be completed in 1999 and building work carried out in the period 2000-2002. The project is expected to be completed within the first six months of 2002, and construction is planned to take place in stages in order to maintain the level of research activity. It is with great expectations that the laboratory looks forward to start using the new facilities and considers it the best jubilee present imaginable.

Finally I would like to thank the Board and the entire staff for their fine cooperation during the past year.

N. Bille

2. Management and organization

2.1 Board of the Danish Pest Infestation Laboratory

Members:

Niels Ørnbjerg
Dansk Bilharziose Laboratorium
Chairman

Lars Damberg
Danish Pest Infestation Laboratory

Annie Enkegaard
Danish Institute of Agricultural Services, Flakkebjerg

Peter Esbjerg
Royal Veterinary and Agricultural University
Vice-chairman

Lise Stengård Hansen
Danish Pest Infestation Laboratory

Hans Kristensen
Danish Agricultural Advisory Centre

Elisabeth Nørbygaard
Danish Medicines Agency

Ellis Byrgiel Sommer
Research Secretariat, Danish Directorate for Development
Ministerial representative without voting right

2.2 Staff 1998

DIRECTOR
Nils Bille

SECRETARIAT, ACCOUNTS AND BOOKKEEPING
Inge Børgesen
Marianne Christensen (part-time)
Lisbeth Gammelgaard (part-time)
Jette Hansen (part-time)
Ilse Hall Jensen
Kirsten Engell Jørgensen (part-time)
Hanne Olsen
Vibeke Rostgaard Schmidt
Annette Pilgaard (until 08.04)

DEPARTMENT OF ENTOMOLOGY

Scientists
Jørgen Brøchner Jespersen (Head)
Lise Stengård Hansen* (part-time)
Karl-Martin Vagn Jensen*
Ole Østerlund Kilpinen
Michael Kristensen*
Kim Søholt Larsen* (until 30.11)
Mette Knorr Lauridsen (part-time) (from 01.09)
Henri Mourier (until 31.01)
Per Sejerø Nielsen*
Henrik Skovgård Pedersen
Anne Marie Rasmussen (part-time) (from 01.02)
Andrew Spencer
Tove Steenberg*

* Senior Scientists

Technicians
Aase Borges (part-time)
Ulrik Cold
Lars Damberg
Eva Hald

Henriette Hansen
Nicolai Hansen
Gitte Jensen
Dorthe Kyster (from 17.09)
Marianne Søs Ludvigsen (until 30.09)
Bodil Malle Pedersen (part-time)
Kirsten Peschel
Jonna Rungsøe (until 30.06)
Minna Wernegreen (part-time)

MAMMAL DEPARTMENT

Scientists
Herwig Leirs (Head)
Thomas Bolbroe (from 07.12)
Ann-Charlotte Heiberg (from 01.06 until 31.07)
Jens Lodal

Technicians
Sarah Adams
Kristian Fordsmand
Folmer Jensen

TECHNICAL MANAGEMENT
Jørgen Christensen

Assistants in the workshop
Githa Christensen (1) (until 31.03)
Ib Bjarne Nielsen (1)
Volker Pieper (1) (from 02.06)
Mirjana Zibar (1) (from 19.10)

(1) Paid using special reemployment funds

2.3 Ph.D. and M.Sc. students

Michael Carlsen, Ph.D. student (University of Aarhus)
Ann-Charlotte Heiberg, Ph.D. student (University of Copenhagen - from 24.08)
Vibeke Kalsbeek, Ph.D. student (Royal Veterinary and Agricultural University, Copenhagen)
Saskia Mercelis, Ph.D. student (University of Antwerp, Belgium)
Christian Nansen, Ph.D. student (Royal Veterinary and Agricultural University, Copenhagen - from 01.05)
Solveig Vibe-Petersen, Ph.D. student, Royal Veterinary and Agricultural University, Copenhagen)

Thomas Bolbroe, M. Sc. student (University of Copenhagen - until 30.11)
Lars Dag Erichsen, M. Sc. student (University of Copenhagen - until 31.08)
Ditte Hendrichsen, 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 Svendsen, 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 participated in the WHO Pesticide Evaluation Scheme (WHOPES) informal Consultation on the “Guideline specifications for household insecticide products”, 3-6 February, in Geneva, Switzerland.

J. B. Jespersen participated in the first Workshop of the Working Group on Myiasis in Livestock, Cost Action 833, 3 April, London, UK.

H. Leirs participated at the Workshop on Management of Rodent Pests in Southeastern Asia at the International Rice Research Institute, Los Baños, the Philippines, 5-8 April 1998. He gave a special seminar entitled “Rodent management in Eastern Africa: challenges and prospects for the future.”

V. Kalsbeek participated in the British Mycological Society’s International Symposium “The future of fungi in the control of pests, weeds and diseases”, Southampton, UK, 5-9 April, and presented a poster authored by Tove Steenberg, entitled “Entomopathogenic potential of Verticillium and Acremonium species”.

A. Spencer attended a discussion meeting held 8-9 April by the Royal Society (UK) “Insecticide resistance: from mechanisms to management”.

J. B. Jespersen participated in the first Workshop of the Working Group on Mange in Livestock, Cost Action 833, 20 April, Brussels, Belgium.

J. B. Jespersen attended a Danida meeting on “Danish research in developing countries”, 5 May, in Copenhagen, Denmark.

J. B. Jespersen attended the Second ENMARIA business meeting and a workshop on “Pesticide resistance in horticultural crops”, 12-15 May, in Almería, Spain. Together with Ian Denholm he presented a paper entitled “Introduction to the workshop and background to ENMARIA”.

O. Kilpinen participated in the International Symposium on Ecology of Bird Parasites in Vilnius, Lithuania, 25-28 June, and presented a paper entitled “Behavioural responses of the chicken mite *Dermanyssus gallinae* to host-related stimuli.

M. Carlsen participated in the Euro-American Mammal Congress, 19-24 July, in Santiago de Compostela, Spain, where he presented a poster entitled "Survival in *Microtus agrestis* in a predator exclusion experiment".

A. Spencer attended "Neurotox '98: Progress in Neuropharmacology and Neurotoxicology of Pesticides and Drugs" held in Oxford, UK, 28-31 July.

N. Bille attended "European Society for Emerging Infections, 1st Congress" in Budapest, Hungary, 13-16 September.

L. S. Hansen and K.-M. V. Jensen participated in the 3rd Nordic Symposium on Insect Pest Control in Museums in Stockholm, Sweden, 24-25 September. L. S. Hansen presented two papers: (i) entitled "Heat treatment of the common furniture beetle *Anobium punctatum* (Coleoptera: Anobiidae) at temperatures between 45° and 54°C - under dry and humid conditions" co-authored by K.-M. V. Jensen, and (ii) entitled "The common furniture beetle *Anobium punctatum* in Danish churches - pest densities and moisture contents monitored for three years". K.-M. V. Jensen presented a paper entitled "Evaluation of chemical methods for prevention of damage to textiles due to Dermestidae and Tineola bisselliella (Lepidoptera: Tineidae)", co-authored by L. S. Hansen.

J. B. Jespersen participated in the Management Committe Meeting and the First Annual Workshop of the EU-funded Cost Action 833 on "Mange and Myiasis in Livestock", 30 September - 4 October, in Thessaloniki, Greece.

H. Leirs and S. Vibe-Petersen participated in the International Conference on Rodent Biology and Management, Beijing, China from 5-9 October. H. Leirs was a member of the Organising Committee; he convened the Symposium "Ecologically-based management" and chaired the Closing Ceremony. He presented two papers entitled "Populations of African rodents: models and the real world" and "Ecologically based rodent management in Africa: no quick solutions for urgent problems" and one poster "Palatability and toxicity tests with a systemic insecticide in a rodenticide bait for rat and flea control" co-authored by K. S. Larsen and J. Lodal. S. Vibe-Petersen presented a poster entitled "Predation pressure and population dynamics in African *Mastomys* rats: possibilities for integrated pest management."

K. S. Larsen participated in XIth European SOVE Meeting, Lisboa, Portugal, 13–17 October and presented the paper "Palatability and toxicity tests of fipronil as a systemic insecticide in a rodenticide bait for rat and flea control". This paper was co-authored by H. Leirs and J. Lodal.

J. B. Jespersen participated in the first meeting of the Global Collaboration for the Development of Pesticides for Public Health (GCDPP), 14-15 October, in Geneva, Switzerland.

P. S. Nielsen participated in the 7th International Working Conference on Stored-Product Protection in Beijing, China, 14-19 October, where he presented a paper entitled "The use of *Blattisocius tarsalis* (Acari: Ascidae) for biological control in flour mills".

J. B. Jespersen participated in the Meeting of the FAO Working Group on Parasite Resistance and the FAO/INDUSTRY Contact Group Meeting, 4-6 November, Rome, Italy.

H. Leirs attended the "Mini-Symposium in Honour of Walter Verheyen", 26 November, Antwerp, Belgium. He was a member of the organizing committee, chaired the afternoon session and presented a paper "Veeltepelratten in de regen."

3.2 Visits and co-operation

DPIL staff paid visits to the following countries:

14 February–3 March, H. Leirs visited the Sokoine University of Agriculture, Morogoro, Tanzania, to start the field work of two Ph.D.-projects.

19 February, J. B. Jespersen visited Silvandersson, Sweden.

5-8 April, H. Leirs travelled as a DANIDA-consultant to the International Rice Research Institute, Los Baños, the Philippines, to discuss ongoing and future projects on rat problems and control in rice fields.

7-9 September, E. Hald and K. S. Larsen visited Novartis in Basle and Sct. Aubin, Switzerland.

23 September, N. Bille, J. B. Jespersen, H. Leirs, J. Lodal, K.-M. V. Jensen and L. S. Hansen visited Anticimex, Stockholm, Sweden.

24 October–8 November, H. Leirs visited the Sokoine University of Agriculture, Morogoro, Tanzania, in the framework of several ongoing rodent projects there.

8-10 December, H. Leirs visited the Museum of Natural History at Tórshavn, Faroe Islands, to discuss the possibilities of a research project on Norway rat problems in breeding sea bird colonies.

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

13 January, Senior Officer (parasitology) Jørgen Hansen, Animal Production and Health Division, FAO, Rome, Italy, to discuss pesticide resistance in livestock insect and mite pests.

10 February, Dr. Ian Denholm, IACR Rothamsted, UK, to discuss ENMARIA business matters.

11 February, Dr. Eva Veronesi, Centro Agricolture Ambiente, Bologna, Italy, to discuss fly and mosquito control.

4 May, Professor and Director, G. Kouri, Instituto de Medicina Tropical, Havana, Cuba, to discuss insect vector control.

10-17 June, Dr. Jan-Erik Bergh, Dalarna University College, Sweden, to do research on a project on museum pests.

22 June, a group of 32 people from the State Plant Protection Administration, Brno, Czech Republic, visited the laboratory to discuss plant protection problems especially concerning rodents. Short introductory talks were given by members of the staff: (1) J. Lodal: Rat control and rodenticide resistance monitoring in Denmark; (2) M. Carlsen: Predator pressure and population dynamics of *Microtus agrestis*; and (3) J. Lodal: Control of voles (*Microtus, Arvicola*) in Denmark.

29 June-1 July, Robin Wilkin, Pest Control Consultant, UK to discuss aspects of pest control in flour mills.

23 August-4 September, Professor Bradley A. Mullens, University of California, USA, to do research on *Entomophthora muscae* and *Musca domestica*.

16 September, Professor Howard Whisler, University of Washington, WA, USA, to discuss rearing of the lesser housefly, *Fannia canicularis*.

22 September; Dr. Tom Strang, Canadian Conservation Institute, Ottowa, Canada, to discuss aspects of pest control in museums.

3 December, Dr. Jan-Erik Bergh, Dalarna University College, and Monika Åkerlund, Swedish Museum of Natural History, both Sweden, to discuss a collaborative 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.

Since 1991 J. B. Jespersen has been a member of the WHO Expert Advisory Panel on Vector Biology and Control, and in 1996 he accepted an invitation to serve as a member for a further period of four years. In 1998 J. B. Jespersen participated in the WHO Pesticide Evaluation Scheme (WHOPES) informal Consultation on the "Guideline Specifications for Household Insecticide Products (3-6 February), and the first meeting of the Global Collaboration for the Development of Pesticides for Public Health (GCDPP) (14-15 October), in Geneva, Switzerland.

3.4 FAO Expert Panel on Resistance in Parasites in Livestock

In 1998 J. B. Jespersen became a member of the FAO Panel of Experts on Resistance in Parasites in Livestock, and he participated in a Working Group Meeting and a joint FAO/Industry Contact Group Meeting, 4-6 November, in Rome, Italy.

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) on 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 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 13 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.

The 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 while the second workshop took 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 sponsors technical training visits, focusing on techniques for monitoring resistance and evaluating resistance. Until now 8 such training visits have been funded.

The primary long-term objective of ENMARIA is to encourage close 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:

Dr. Jørgen B. Jespersen
Danish Pest Infestation Laboratory
Skovbrynet 14
DK-2800 Lyngby
Denmark
Tel.: (45) 45 87 80 55
Fax: (45) 45 93 11 55
E-mail: j.b.jespersen@ssl.dk

Dr. Ian Denholm
IACR-Rothamsted
Harpenden
Herts, AL5 2JQ
United Kingdom
Tel.: (44) 1582 763 133
Fax: (44) 1582 762 595
E-mail:
ian.denholm@bbsrc.ac.uk

ENMARIA has established a website giving information about its activities. The home page includes 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. The address is: < http://www.res.bbsrc.ac.uk/enmaria/>

3.7 Mange and Myiasis in Livestock in Europe

As part of the European co-operation in the field of scientific and technical research, a European Concerted Action 833 on Mange and Myiasis in Livestock was established in 1998 with the following objectives:

1. To develop accurate means of diagnosis of mange and myiasis in livestock and so prevent suffering and improve animal welfare.

2. To develop effective and environmentally sensitive methods of treatment and control of these diseases and so increase economic performance and decrease pressure on the environment.

3. To increase the epidemiological knowledge of these diseases in order to facilitate control and eradication programmes.

Altogether, 16 countries are involved in implementation of the COST Action 833, which is organized by the Management Committee. In 1998 J. B. Jespersen was appointed the Danish representative of the Management Committee. In 1998 J. B. Jespersen participated in two Management Committe meetings, two Working Group meetings and a Workshop.

3.8 EPPO (European and Mediterranean Plant Protection Organization)

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

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 636 persons participated.

17-18 March and 11-12 August, two courses on the biology and control of insects, mites and rodents were 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

20 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.

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

17 April, T. Steenberg, V. Kalsbeek, L. S. Hansen and T. S. Mortensen gave lectures on different aspects of microbial and biological pest control for a group of students from the Royal Veterinary and Agricultural University

23 April, J. Lodal gave a lecture on the present situation of resistance to anticoagulants in the brown rat in Denmark at a meeting of Brancheforeningen for Kommunal Skadedyrbekæmpelse (an association of pest control companies involved in municipal pest control).

30 April, J. B. Jespersen gave two lectures on “Flies and mosquitoes” for students at the Royal Veterinary and Agricultural University, Copenhagen.

26 May, 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.

10 June, J. B. Jespersen and H.Leirs gave lectures in a course on “Tropical Medicine” for senior military health staff, intending to operate in foreign countries.

26 August, A.-C. Heiberg gave a lecture at a graduate course “Molecular evolution” at the DNA-laboratory, University of Copenhagen, on microsatellites in general.

4 September, A.-C. Heiberg gave a lecture at a graduate course “Molecular evolution” at the DNA-laboratory, University of Copenhagen, on a project presentation with special emphasis on the usage of molecular markers for population genetic studies

4 November, T. Steenberg and K.-M. V. Jensen gave lectures on “Microbial control of flies on pastured cattle” and “Biology and importance of Diptera associated with pastured livestock” at the Organic Agricultural School, Åbybro.

16 December, J. B. Jespersen gave a lecture on “Litter beetles in broiler farms; biology and control” for broiler farmers in North Jutland.

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 chairman of the external examiners at the Veterinary Faculty, Royal Veterinary and Agricultural University, Copenhagen, and external member of the Senate.

L. S. Hansen served as an external supervisor for Ph.D. student Charlotte Danielsen, University of Copenhagen, and Ph.D. student Christian Nansen, Royal Veterinary and Agricultural University, 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.

L. S. Hansen served as an external examiner for a student at the Royal Danish Academy of Fine Arts - School of Conservation, Copenhagen.

K.-M. V. Jensen served as supervisor for one M.Sc. student at the University of Aarhus.

J. B. Jespersen served as supervisor for one M.Sc. student at the University of Copenhagen, one M.Sc student and one Ph.D. student at the Royal Veterinary and Agricultural University, one M.Sc. Student at Roskilde University and one student at Technical University of Denmark.

J. B. Jespersen served as a referee for the journal *Entomologica Experimentalis et Applicata (1)*.

M. Kristensen served as a referee for the *Bulletin of Entomological Research*.

H. Leirs served as a supervisor for one Ph.D. student at the Royal Veterinary and Agricultural University, Copenhagen, one Ph.D. student at the University of Copenhagen, one Ph.D. student at the University of Antwerp (Belgium), one Ph.D. student at the Sokoine University of Agriculture, Morogoro (Tanzania).

H. Leirs served as an adviser to one M.Sc. student at the University of Copenhagen, one M.Sc. student at the University of Aarhus and one M.Sc. student at the University of Oslo (Norway). He also regularly advised students at the Royal Veterinary and Agricultural University, Copenhagen.

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

H. Leirs served as a referee for *Mammalia* (5), *Journal of Tropical Ecology* (1), *Journal of Zoology* (2); as editor of a multi-authored book to be published in 1999, he reviewed 4 contributions and commented on several others.

H. Leirs served as a reviewer for the European Union (DG XII - ISTC programme) and for several foreign institutes and funds.

J. Lodal served as a referee for the *Journal of Applied Ecology (2)*.

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

T. Steenberg served as a supervisor for one M.Sc. student at the University of Copenhagen and one Ph.D. student at the Royal Veterinary and Agricultural University

5. Advisory work

5.1 Number of inquiries arranged by species

In 1998 the DPIL answered approximately 12.300 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, 74% were telephone calls, 22% letters (often with animals enclosed for identification) and 4% 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 products 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 1998 there were 13 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 the common black ant (*Lasius niger)*, hornets (*Paravespulae spp.*), the mouse (*Muridae*), headlice (*Pediculus capitis*), the Indian meal moth (*Plodia interpunctella*), the common furniture beetle (*Anobium punctatum*) and a mortar-attacking bee (*Colletes daviesanus*). Together these 7 subjects made up 40% of the total number of inquiries.

Table 5a. Number of inquiries in 1998

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

	Thysanura	**Børstehaler**	
*	*Lepisma saccharina*	Sølvkræ	143
*	*Thermobia domestica*	Ovnfisk	3
*	**Collembola**	**Springhaler**	8
	Orthoptera	**Retvinger**	
*	*Acheta domestica*	Husfårekylling	40
*	*Tachycines asynamorus*	Væksthusgræshoppe	1
	Orthoptera spp.	Retvinger div.	1
	Blattaria	**Kakerlakker**	
	Blatta orientalis	Orientalsk kakerlak	5
*	*Blattella germanica*	Tysk kakerlak	80
	Periplaneta americana	Amerikansk kakerlak	8
	Periplaneta australasiae	Australsk kakerlak	4
*	*Supella longipalpa*	Brunstribet kakerlak	2
	Blattaria spp.	Kakerlakker div. ..	40
	Isoptera	**Termitter**	6
	Dermaptera	**Ørentviste**	
*	*Forficula auricularia*	Alm. ørentvist	48
*	**Copeognatha**	**Støvlus**	200
	Mallophaga	**Pelslus og fjerlus**	3
	Siphunculata	**Lus**	
*	*Pediculus capitis*	Hovedlus	519
	Pediculus corporis	Kropslus	9
*	*Phthirus pubis*	Fladlus	11
	Siphunculata spp.	Lus div.	4
*	**Thysanoptera**	**Trips**	24

	Latin	Dansk	Antal
	Hemiptera	**Næbmunde**	
*	*Cimex lectularius*	Væggelus	121
*	*Reduvius personatus*	Støvtæge	9
	Hemiptera spp.	Tæger, bladlus, cikader div.	54
	Neuroptera	**Netvinger**	
*	*Chrysopa* spp.	Guldøjer	4
	Lepidoptera	**Sommerfugle**	
*	*Aphomia sociella*	Humlevoksmøl	66
*	*Caradrina clavipalpis*	Tagorm	1
*	*Endrosis sarcitrella*	Klistermøl	14
*	*Ephestia kuehniella*	Melmøl	25
*	*Hofmannophila pseudospretella*	Alm. frømøl	42
*	*Ochsenheimeria vacculella*	Stængelmøl	1
*	*Plodia interpunctella*	Tofarvet frømøl	551
*	*Tinea pellionella*	Pelsmøl	43
*	*Tineola bisselliella*	Klædemøl	90
	Lepidoptera spp.	Sommerfugle div.	102
	Coleoptera	**Biller**	
*	*Alphitobius diaperinus*	Lille melbille	4
	Amphimallon solstitiale	Sankthans-oldenborre	7
*	*Anobium punctatum*	Alm. borebille	586
*	*Anoplodera rubra*	Rød blomsterbuk	6
*	*Anthrenus* spp.	Tæppebiller	311
*	*Attagenus pellio*	Alm. pelsklanner	34
*	*Attagenus smirnovi*	Brun pelsklanner	340
	Bostrychidae	Bostrychider	10
*	*Callidium violaceum*	Violbuk	19
*	*Carabidae*	Løbebiller	43
	Cerambycidae .	Træbukke div.	11
	Clytus arietis	Hvepsebuk	3
	Coccinellidae	Mariehøns	5
*	*Criocephalus rusticus*	Brun træbuk	21
	Cryptolestes ferrugineus	Rustfarvet kornbille	4
*	*Cryptophagus* spp.	Skimmelbiller	13
*	*Dermestes haemorrhoidalis*	Husklanner	97
*	*Dermestes lardarius*	Flæskeklanner	87
	Dermestes maculatus		2
*	*Ernobius mollis*	Blød borebille	9
	Europhryum confine	Boresnudebille	1

*	*Hadrobregmus pertinax*	Rådborebille	17
*	*Hylesinus fraxini*	Askebarkbille	1
*	*Hylotrupes bajulus*	Husbuk	40
*	*Lasioderma serricorne*	Tobaksbille	39
*	*Lyctus* spp.	Splintvedbiller	12
	Melolontha melolontha	Alm. oldenborre	3
*	*Nacerdes melanura*	Bolværksbille	4
	Necrobia sp.	Koprabille	1
*	*Ocypus olens*	Stor rovbille	1
	Oryctes nasicornis	Næsehornsbille	3
	Oryzaephilus mercator	Jordnøddebille	15
*	*Oryzaephilus surinamensis*	Savtakket kornbille	53
*	*Otiorrhynchus sulcatus*	Væksthussnudebille	14
*	*Otiorrhynchus* spp.	Øresnudebille	31
	Phyllopertha horticola	Gåsebille	7
*	*Phymatodes testaceus*	Bøgebuk	68
*	*Pselactus spadix*	Alm. boresnudebille	4
	Ptilinus pectinicornis	Kamhornet borebille	1
	Ptinus fur	Alm. tyvbille	9
	Ptinus tectus	Australsk tyvbille	3
*	*Reesa vespulae*	Amerikansk klanner	8
	Scolytidae	Barkbiller	30
*	*Sitona lineatus*	Stribet bladrandbille	5
*	*Sitophilus granarius*	Kornsnudebille	34
*	*Sitophilus oryzae*	Rissnudebille	32
	Sitophilus zea-mais	Majssnudebille	1
	Staphyllinidae	Rovbiller	35
*	*Stegobium paniceum*	Brødbille	124
*	*Tenebrio molitor*	Melbille	82
	Thylodrias contractus	Larveklanner	2
	Tribolium castaneum	Kastaniebrun rismelbille	2
*	*Tribolium confusum*	Rismelbille	47
*	*Tribolium destructor*	Lysolbille	4
	Trogoderma angustum	Smal frøklanner	8
*	*Trogoderma granarium*	Khabrabille	1
*	*Xestobium rufovillosum*	Egens borebille	6
	Coleoptera spp.	Biller div.	83
	Hymenoptera	**Årevinger**	
	Andrena spp.	Jordbier	56
*	*Apis mellifica*	Honningbi	33
*	*Bombus* spp.	Humlebier	63

*	*Camponotus* spp.	Herculesmyrer	31
*	*Colletes daviesanus*	Murbi	464
	Formica rufa	Rød skovmyre	54
	Formica spp.	Formica-myrer	92
	Lasius fuliginosus	Orangemyre	23
*	*Lasius niger*	Sort havemyre	1145
*	*Lasius umbratus and others.*	Gule myrer	51
*	*Monomorium pharaonis*	Faraomyre	46
	Osmia spp.	Murerbier	67
*	*Paravespula* spp.	Gedehamse	1135
*	*Siricidae*	Træhvepse	14
	Sphecoidae	Gravehvepse	9
*	*Vespa crabro*	Stor gedehams	55
	Hymenoptera spp.	Årevinger div.	33
	Diptera	**Tovinger**	
	Bibionidae	Hårmyg	3
	Borboridae	Springfluer	6
*	*Calliphoridae*	Spyfluer	55
*	*Ceratopogonidae*	Mitter	5
	Chironomidae	Dansemyg	5
*	*Crataerina pallida*	Mursejlerluseflue	1
	Culicidae	Stikmyg	48
*	*Drosophila* spp.	Bananfluer	72
	Eristalis spp.	Dyndfluer	3
	Fannia canicularis	Lille stueflue	8
*	*Musca autumnalis*	Efterårsflue	1
*	*Musca domestica*	Stueflue	28
*	*Mycetophilidae*	Svampemyg	41
*	*Ornithomyia* spp.	Lusfluer	*5*
	Phoridae	Pukkelfluer	4
*	*Pollenia* spp.	Klyngefluer	55
*	*Psychodidae*	Sommerfuglemyg	56
	Stehepteryx hiriundinis	Svaleluseflue	3
	Stomoxys calcitrans	Stikflue	7
	Syrphidae	Svirrefluer	4
*	*Tabanidae*	Klæger	5
*	*Thaumatomyia notata*	Græsflue	5
	Tipulidae .	Stankelben	4
	Diptera spp.	Tovinger div.	95
	Siphonaptera	**Lopper**	

	Archaeopsyllus erinacei	Pindsvineloppe	1
	Ceratophyllus spp.	Fuglelopper	104
*	*Ctenocephalides* spp.	Katte- og hundelopper	331
	Ceratophyllus sciurorum sciurorum	Egernloppe	4
*	*Pulex irritans*	Menneskeloppe	5
	Siphonaptera spp.	Lopper div.	49
	Pests on textiles	Tekstilskadedyr	184
	Pests in food	Kolonialskadedyr	31
	Pests in wood	Træskadedyr	64
	Various insects	**Diverse insekter**	105
	Acarina	**Mider**	
*	*Acarus siro*	Melmide	17
*	*Argas reflexus*	Duemide	1
*	*Bryobia praetiosa*	Brunmide	34
*	*Cheyletiella* spp.	Pelsmider	10
	Dermacentor marginatus	Flåt	2
*	*Dermanyssus* spp.	Fuglemider	20
*	*Dermatophagoides* spp.	Husstøvmider	10
*	*Glycyphagus domesticus*	Husmide	12
*	*Ixodes ricinus*	Skovflåt	98
*	*Rhipicephalus sanguineus*	Husflåt	11
*	*Sarcoptes scabiei*	Fnatmide	9
*	Mites in grain, straw and hay	Lagermider	4
	Acarina spp.	Mider div. .	34
*	**Araneae**	**Edderkopper**	40
	Scorpiones	**Skorpioner**	2
*	**Pseudoscorpiones**	**Mosskorpioner**	6
*	**Diplopoda**	**Ægte tusindben**	65
	Chilopoda	**Skolopendre**	
*	*Geophilus carpophagus*	Jordskolopender	3
	Chilopoda spp.	Skolopendre div. .	13
*	**Oniscoidea**	**Bænkebidere**	51

	Oligochaeta	**Sadelbørsteorme**	
	Lumbricidae	Regnorme	13
	Nematoda	**Rundorme**	6
	Gastropoda	**Snegle**	
*	*Limacidae*	Kældersnegle	48
	Arion lusitanicus	Iberisk skovsnegl	240
	Gastropoda spp.	Snegle div. ..	45
	Amphibia	**Padder**	2
	Lamellibranchiata	**Muslinger**	
	Teredo navalis	Pæleorm	2
	Reptilia	**Krybdyr**	2
	Aves	**Fugle**	
*	*Columba livia domestica*	Tamdue	93
	Laridae.	Måger	8
	Pica pica	Husskade	1
	Aves spp.	Fugle div. .	10
	Mammalia	**Pattedyr**	
	Apodemus flavicollis	Halsbåndmus	21
*	*Arvicola terrestris*	Mosegris	257
	Chiroptera spp.	Flagermus	7
	Felis domestica	Huskat	3
*	*Martes foina*	Husmår	307
	Meles meles	Grævling	4
*	*Muridae*	Mus	425
*	*Rattus norvegicus*	Brun rotte	173
	Rattus rattus	Husrotte	9
	Sciurus vulgaris	Egern	1
*	*Talpa europaea*	Muldvarp	248
	Vulpes vulpes	Ræv	13
	Mammalia spp.	Pattedyr div. .	37
	Various animals	**Diverse dyr**	57
	Imaginary animals	**Indbildte dyr**	45

5.2 Some of the cases and characteristic variations in the number of inquiries in 1998

Indian meal moth (*Plodia interpunctella*) was also this year recorded in greater numbers than ever before. In September and October 1997 the number of inquiries about this species was very high compared with previous years. These high occurences probably explain why more calls than usual in the first half of the year, whereas there were fewer calls than normally in the rest of 1998. The high number of Indian meal moth could be due to a large population build-up in the unusual warm months of August and September of the previous year. It will be interesting to see how things will develop in 1999.

In the summer months ***Osmia*** spp. (single living bees) were registered in the highest numbers since 1993. Inquirers were often convinced that these bees were mortar attacking bees (*Colletes daviesanus*) that would damage their houses. When samples were sent in, they nearly always proved up to be *Osmia* spp. These bees are not harmful to buildings and only slightly aggressive, so in most cases there is no need for control.

Buprestis aurulenta (a wood destoying beetle) was found in the roof of a ten-year-old house in Jutland. The roof had been opened to allow for repairs, and a live specimen and tracks in the wood constructions because of larvae activity were seen. It is very unusual to see *Buprestis aurulenta* in Denmark. Normally it occurs in North America and has probably been introduced to Denmark with the wood that was used to construct the house. In nature the larvae are living in sick and dying trees in the forest, and the larval period might be prolonged to up to 25 years in the cases when the wood has been built into a house and dries out. In Denmark this species will probably never become economically important.

There were a lot of inquires concerning the snail, ***Arion lusitanicus*** from people concerned that they had seen this snail in their garden, where it can be a serious pest. This summer *Arion lusitanicus* has been recorded in many parts of the country. A way to control *Arion lusitanicus* in private gardens is to collect them and then kill them with boiling water.

In the autumn there were a lot of calls concerning ***Diplopoda***, which were seen in very large numbers crawling outside and along buildings. Some callers told that they could collect them in buckets and still many remained. *Diplopoda* sometimes congregate and migrate in large numbers. The very wet summer and autumn of 1998 may have created good conditions for these animals living in damp places and caused their massive appearance. Even though the experience can be unpleasent, *Diplopoda* do no harm to humans or buildings.

Headlice, *Pediculus capitis*, have increased again this year. There are still a lot of problems with children having headlice especially in schools and nurseries.

Cat fleas, *Ctenocephalides felis*, have been recorded in falling numbers for the last three years. This might be the result of an increasing use of preventive formulations and the many new products on the market that pet owners find easy to use.

Scientific and technical work

6. Flies

6.1 Chemical control of *Musca domestica*

6.1.1 Field evaluation of Fipronil Fly-bait Gel for control of the housefly *Musca domestica*

At the request of the manufacturer, the efficacy of a paint-on bait (a.i. 0.1% fipronil) for control of the housefly, *Musca domestica,* was evaluated in a field trial. The objective was to evaluate the efficacy of the bait formulation in animal houses and to evaluate the risk of a rapid development of resistance to fipronil.

The bait was used for housefly control during the whole fly season on three animal farms. Two other farms were used as controls without use of any chemical control measures against houseflies. The control effect of the treatments was monitored by a weekly estimate of the number of houseflies. Resistance to fipronil was determined by standard feeding tests on strains collected immediately before the first treatment with fipronil in the animal units and again on strains collected once or twice late in the season. Moreover, the resistance to dimethoate and pyrethrin/PBO was determined by topical application tests.

The quantity of bait applied for one complete treatment of an animal unit was 0.1g fipronil (a.i.) per 100 m^2 base area of the unit. On one of the farms, T3, only one application was made, while on the two other farms, T1 and T2, a second treatment was made four weeks after the initial treatment.

On two of the treated farms, T1 and T2, the housefly density was above the nuisance level when the initial bait application was made; and in both, the housefly reproduction was intensive at the time. The bait restricted the growth of the housefly populations, but it could not reduce the number of flies to a level below the nuisance level on these two farms. On the third treated farm, T3, the initial fipronil application was made when the housefly population was still below the nuisance level. No further bait applications were made, and the number of houseflies remained below nuisance level during the whole season. The 1998 fly season was exceptionally cold, and as the air temperature in the animal units of the T3 farm was dependent on the outdoor temperature, the number of houseflies on this farm would probably not have increased very much above the nuisance level even in the absence of chemical control measures.

A small longevity trial, where paralyzed or dead flies were collected in receptacles below fipronil-treated plywood boards in the animal units, indicated that the efficacy of the bait was unchanged during a 6-week period.

The strains collected showed no indications of increased resistance to fipronil in the three housefly populations during the 9- to 16-week period of fipronil exposure in the animal units.

M. Knorr Lauridsen and J. Brøchner Jespersen

6.1.2 Laboratory evaluation of CGA 293 343 paint-on bait for control of the housefly *Musca domestica*

Three paint-on-bait formulations, WP 10, WP 5 and GB 1, with 10%, 5% and 1% CGA 293’343 active ingredient were evaluated under laboratory conditions for efficacy against the housefly *Musca domestica*. A reference paint-on-bait which contained 10% azamethiphos, a reference paint-on-bait containing 1.1% methomyl and an untreated control were included in the evaluation.

Adult flies of a susceptible *Musca domestica* laboratory strain were allowed to feed on bait during 48 hours after the release into a large test chamber, in which they had access to a plywood board treated with the test formulation. The mortality was recorded by counting of the number of knocked down and dead flies after ½, 1, 2, 4, 7, 24 and 48 hours of exposure to the bait. The mortality was recorded as “overall mortality” (all flies knocked down and dead at the specific time of recording) and as “immediate mortality” (the quantity of the knocked down and dead flies which were caught in a receptacle suspended closely beneath the painted board).

The baits were tested in two situations; (1) as *Non-Choice trials,* in which the flies had only access to water and bait, and (2) as *Choice trials,* in which the flies had access to water, milk powder, sugar and bait.

Mutually compared, the overall killing effect of the three CGA 293’343 formulations did not vary significantly. This was the case in both the Non-Choice and the Choice trials.

The three CGA 293’343 formulations were at least as effective as the two reference baits. In the Non-Choice trials the differences between the CGA 293’343 baits and the two reference baits were small and in general not significant. In the Choice trials in which the flies had access to alternative food sources in addition to the bait, the overall mortality to the three CGA 293’343 baits and to the methomyl reference was in general not significantly different (96-99% after 48 hours). Sensitivity to the azamethiphos reference (87% mortality after 48 hours) was, significantly, the lowest recorded among the toxic baits in the Choice trials.

In both the Non-Choice and the Choice trials, the proportion of immediately killed flies recorded in the receptacles was higher to the two reference baits than to the three CGA 293’343 baits. The proportion of killed flies recorded in the receptacles below the three CGA 293’343 baits was highest for WG 10, intermediate for WG 5, and lowest for GB 1. The mean mortality for WG 10 and WG 5 was not significantly different at any time. In the Choice trials, however, GB 1 had significantly lower mean mortality values in general than WG 10 and WG 5.

M. Knorr Lauridsen and J. Brøchner Jespersen

6.2 Insecticide resistance in *Musca domestica*

6.2.1 Larvicidal efficacy of CGA 293’343 against susceptible strains of houseflies

The larvicidal efficacy of CGA 293’343 was tested in two insecticide susceptible strains of the housefly ($WHOij_2$ and BPM). The efficacy of CGA 293’343 was estimated in standard larvicide tests, where newly laid housefly eggs or third stage instar larvae were seeded on artificial media impregnated with the insecticide.

The lethal concentrations based on the larvicide tests with eggs or third stage instar larvae were estimated by probit analysis. The results showed that CGA 293’343 was not an efficient larvicide at low concentrations.

M. Kristensen and J. Brøchner Jespersen

6.2.2 Larvicidal efficacy of dicyclanil against susceptible strains of houseflies

The larvicidal efficacy of dicyclanil was tested in two insecticide susceptible strains of the housefly ($WHOij_2$ and BPM). The efficacy of dicyclanil was estimated in standard larvicide tests, where newly laid housefly eggs or third stage instar larvae were seeded on artificial media impregnated with the insecticide.

The lethal concentrations based on the larvicide tests with eggs or third instar larvae were estimated by probit analysis. The results showed that dicyclanil is an efficient larvicide against houseflies at low concentrations.

M. Kristensen and J. Brøchner Jespersen

6.2.3 Larvicidal efficacy of dicyclanil in tests with three resistant strains of houseflies

We evaluated the larvicidal efficacy of dicyclanil, cyromazine and diflubenzuron in *Musca domestica* laboratory tests using three strains of houseflies representing different patterns of insecticide resistance. The strains were tested in feeding tests with methomyl and azamethiphos, and in topical application tests with dimethoate and pyrethrin synergized by piperonyl butoxide (PBO) to assess the resistance level to traditionally used insecticides.

One of the three tested strains, 802ab, showed a low level of resistance to dicyclanil. It also showed a low level of resistance to cyromazine, whereas it was susceptible to diflubenzuron. The 802ab population has two components: a dicyclanil susceptible fraction and a dicyclanil resistant fraction. The strain 802ab was moderately resistant to pyrethrin/PBO, dimethoate, azamethiphos and methomyl.

The 381zb strain showed a moderate to low level of resistance to diflubenzuron, whereas it was susceptible to cyromazine and dicyclanil. It was moderately resistant to pyrethrin/PBO and highly resistant to dimethoate. The 807ab strain was almost susceptible to cyromazine and dicyclanil while it was highly resistant to diflubenzuron. It showed a moderate level of resistance to the topically applied pyrethrin/PBO and dimethoate.

The low level of cross-resistance to dicyclanil observed in the cyromazine selected and multi-resistant 802ab strain might be explained by an elevation of the general detoxification system involving glutathione S-transferases and/or P450 monooxygenases. It was not possible to elucidate whether the cross-resistance to dicyclanil observed in 802ab was linked to the low cyromazine resistance or to resistance to other insecticides including the four adulticides tested.

M. Kristensen and J. Brøchner Jespersen

6.2.4 Biochemical and toxicological analysis of CGA 293’343 in susceptible and resistant strains of the housefly *Musca domestica*

The mechanism(s) responsible for cross-resistance to the novel insecticidal compound CGA 293’343 in housefly strains were investigated by topical application of the synergists piperonyl butoxide (PBO) or S,S,S-tributyl phosphorotrithioate (DEF) prior to feeding bioassay on CGA 293’343 impregnated sugar.

The organophosphate, carbamate, and pyrethroid, multiresistant 381zb selected laboratory strain (selected by dimethoate and permethrin) was moderately/highly resistant to CGA 293’343. The resistance was partly synergized by PBO, while DEF had no effect.

The methomyl resistant 690ab selected laboratory strain (selected by methomyl) was low to moderately resistant to CGA 293’343. The resistance was partly synergized by PBO. DEF had no effect.

The organophosphate, carbamate, and pyrethroid, multiresistant 791a field strain was moderately to highly resistant to CGA 293’343. The resistance was partly synergized by PBO, whereas DEF had no effect.

The effect of CGA 293’343 on AChE activity was tested. In the dose range relevant for the use of CGA 293’343 there was no effect of the compound on AChE activity.

Glutathione S-transferase activities were measured with the 1-chloro-2,4-dinitrobenzene (CDNB) and 3,4-dichloronitrobenzene (DCNB) substrates. P450 monooxygenase activity was measured with the substrate ρnitroanisole (PNA). Within the wide range of activity levels measured in the housefly strains used, we did not observe a correlation with any of the activities and CGA 293´’343 toxicity.

PBO acts as a synergist of CGA 293’343 resistance in the resistant strains 381zb, 791a and 690ab. Thus, a P450 monooxygenase enzyme activity was expected to be responsible for this effect. However, full susceptibility was not achieved by adding PBO: resistance factors of between 5 and 10 remained. This low to moderate non-synergizable resistance did not correlate with any of the enzyme activities measured and could be due to natural variation of the CGA 293’343 target site.

M. Kristensen. A. Spencer and J. Brøchner Jespersen

6.2.5 Resistance tests in housefly 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 the DPIL by collection of houseflies on farms in various parts of the country and tests of resistance on their 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 are still registered for housefly control in Denmark. Larvicides containing the insect development inhibitors diflubenzuron or cyromazine were effective where breeding places could be treated properly. Larvicide usage is increasing in Denmark.

In the 1997 survey we found the beginnings of resistance towards the benzoylurea diflubenzuron. This had to some extent been observed earlier. For the first time we found field strains resistant to cyromazine.

We found resistance to diflubenzuron in strain 790b and a tendency to resistance development in five other strains. We found resistance to cyromazine in strain 791a and a tendency to resistance in three other strains. No correlation between diflubenzuron and cyromazine tolerance was observed. In the laboratory we applied a selection pressure with either diflubenzuron or cyromazine to four strains. In strain 807ab we were able to select a high level of resistance to diflubenzuron, while and in strain 790b a moderate level of resistance to diflubenzuron was achieved. The selected strain 807bb now kept at DPIL is approximately 100-fold resistant to diflubenzuron at LC_{50}, but susceptible to cyromazine. We were not able to select for cyromazine resistance in 791a. The highest level of cyromazine resistance, 8-fold, was created by the selection of strain 802ab. We are currently trying to identify the larvicide resistance mechanisms in housefly larvae.

M. Kristensen and J. Brøchner Jespersen

6.2.6 Resistance mechanisms of houseflies

Sixty-three individuals from each of our laboratory strains 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 butyrate (ρNPB), and the P450 dependent monooxygenase substrate ρ-nitroanisol (ρNA). Specific activity towards the AChE substrate ATCI was measured in 63 individuals from each strain. The effect of three inhibitors, azamethiphos, methomyl and omethoate was also measured on each fly tested. The results gained showed many different insecticide resistance phenotypes.

M. Kristensen and A. Spencer

6.2.7 Laboratory strains kept in 1998

At the end of 1998, the DPIL kept 21 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. Brøchner Jespersen and M.Kristensen

Table 6a. Laboratory strains of *Musca domestica* maintained during 1998

	Strain	Origin	Year	Remarks	Lab pressure
1.	*Strains subjected to periodic insecticidal pressure (adult dipping, exposure to vapour, or feeding with treated sugar) from a compound to which at least part of the population showed clear resistance at the time of collection*				
	17 e	DK	1950		lindane
	150 b	DK	1955		diazinon*
	39 m_2b	DK	1969		tetrachlorvinphos*
	49 r_2b	DK	1970		dimethoate*
	381 zb	DK	1978		permethrin and dimethoate*
	690 ab	DK	1984		methomyl feeding*
	594 vb	DK	1988		azamethiphos feeding*
	213 ab	Swe- den	1957	Pyr-R	pyrethrins/pbo*
	571 ab	Japan	1980	High OP-R	fenitrothion
	698 ab	Burma	1985	(not kdr)	DDT
	790 bb	DK	1997		diflubenzuron
	802 ab	DK	1997		cyromazine
	807 ab	DK	1997		diflubenzuron

* 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	Reverted DDT-R	None
	772 a	DK	1989	Common lab. test strain	None
	791 a	DK	1997	Multi-R	None
3.	*Susceptible strains*				
	BPM	Leiden	1955		None
	WHO Ij_2	Pavia	1988		None
	NAIDM	Texas	1991		None
4.	*Strains with R mechanisms isolated*				
	A_2bb	DK	1982	Super-kdr. Chr. 1, 2 and 3 with marker genes	None
	LPR	USA	1995	Pyr-R kdr, P450 monooxygenase	None

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

6.3.1 Parasitic wasps

The housefly, *Musca domestica* (L), and the stable fly, *Stomoxys calcitrans* (L) are important pests in most confined animal production units in Denmark. The flies are a nuisance to animals as well as to humans and are potential vectors of pathogens. Demands by farmers and the public for alternative or supplementary methods of insecticide control of these flies have increased the last ten years, mainly because of the risk of insecticide residues in animal products, the contamination of the environment and the fact that the flies develop resistance to some of the insecticides in use. One alternative method is biological control, where natural enemies are released to suppress the fly populations below nuisance levels.

The two first years in a project partially funded by the Ministry of Food, Agriculture and Fisheries to evaluate the possibility of the use of parasitic wasps in the control of houseflies and stable flies have resulted in a full description of the species composition and seasonal activity of parasite wasps on confined pig and cattle farms in this country. Furthermore, based on these studies two parasite species, *Spalangia cameroni* and *Muscidifurax raptor* have proven to be promising control candidates of the flies (DPIL, Annual report 1997).

This third year has concentrated mainly on dispersal activity of released parasitoids in a stable environment. The most dominant pupal parasitoid, *S. cameroni* at indoor sites was chosen as the study organism. At each experiment, about 10,000-15,000 individuals were released at the center of a stable on a traditional pig farm. Five experimental releases of *S. cameroni* were conducted from May to October on this farm. Laboratory-reared *M. domestica* puparia were laid out systematically in the stable environment as "traps" in order to make it possible to detect dispersal activity of the female wasps. With fixed intervals from the time of release, the pupal traps were examined for *S. cameroni* individuals. The results were consistent among experiments and showed that female *S. cameroni* within a day disperse little from the point of release whereas the opposite was observed for the males which moved towards the surrounding windows within an hour of release.

The results are important for understanding that if a species like *S. cameroni* is to be used in control of the flies, one important factor to consider is to release the wasp in a large number of locations in the stable environment. However, release efforts can be concentrated to include only the areas in the stable where the flies are commonly known to develop.

The dispersal experiment is to be continued in 1999 with the inclusion of *M. raptor*. Moreover, movement of the two parasite species will be evaluated in the stable environment for one week to see if the picture of dispersal will change.

H. Skovgård Pedersen and J. Brøchner Jespersen

6.3.2 Entomophthora muscae

This work was conducted in co-operation with Professor Bradley A. Mullens, Department of Entomology, University of California, Riverside in the last year of V. Kalsbeek's Ph.D project.

Houseflies (*Musca domestica*) infected with the entomopathogenic fungi *Entomophthora muscae/E. schizophorae* are known to cure themselves of this infection by seeking high temperatures shortly after infection - a phenomenon called "behavioural fever". Two studies were carried out in August/September 1998 in Denmark to evaluate the occurrence and extent of behavioural fever under natural conditions. In the first study conducted on an open organic dairy farm, the pathogen present was *E. muscae* with an average of about 17 nuclei per conidium. In the second study, *E. schizophorae* with four to eight nuclei per conidium was used in the release of infected flies.

(1) At different times of the day on each of four consecutive days, flies were collected with a sweep net from cool indoor and warm outdoor surfaces. The flies were kept individually in the laboratory and, since the incubation time for *E. muscae* is quite constant at a particular temperature, flies dying of mycosis shortly after capture were regarded as being late in incubation and vice versa.

The preliminary results show that the infection level was consistently higher indoors, i.e. at cooler conditions (38%) than outdoors (27% on relatively warm dark surfaces and 15% on sun-exposed feed). Furthermore, the data indicate that a higher proportion of flies collected indoors died of mycosis within the first three days after capture, i.e. late in incubation.

This is in accordance with studies conducted elsewhere, showing that flies seek to cooler areas shortly before they die of *E. muscae.*

(2) To determine whether infected flies prefer warmer surfaces, approximately 3,000 fungus-inoculated (marked with yellow paint; 30% became infected) and 3,000 non-inoculated flies (marked with blue paint) were released on the second day in incubation in an enclosed swine farrowing barn. The flies were reared from wild parents to avoid the unnatural behaviour that may take place in laboratory strains of houseflies. The number of yellow and blue flies was recorded in different areas of the barn with different temperatures including heating lamps that provided resting surfaces with temperatures above 40^{o}C. Observations took place every second hour from 8 a.m. to 6 p.m. for 6 days.

Especially on the day of release, a higher total number of inoculated flies was found on the heating lamps compared to non-inoculated flies which might indicate that behavioural fever took place. Another factor that may indicate behavioural fever was the decrease in initial fungal prevalence from 30% to 5%, two days after release and to 0% four days after release. No yellow flies were observed in high numbers on the cooler surfaces late in incubation and finally only one yellow-marked cadaver was found when the barn was examined thoroughly.

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

6.3.3 Hyphomyceteous fungi

This project was initiated in 1998 and aims to evaluate fungi from the class Hyphomycetes as biological control agents against flies in stables. The natural occurrence of these fungi was studied in houseflies and stable flies collected from a large number of farms. The following species were isolated from houseflies: *Beauveria bassiana*, *Metarhizium anisopliae*, *Paecilomyces fumosoroseus*, *Verticillium lecanii* and *Verticillium fusisporum*. From stable flies we isolated *B. bassiana* and *V. lecanii*. The fungus prevalence was always low (below 5%) and there did not appear to be any correlation between fungus prevalence and time of year.

All fungi have been isolated *in vitro* and will be tested in the next year against the two species of flies in order to select the most suitable isolates for fly control in stables. Furthermore, houseflies were included in a study of the entomopathogenic potential of *Verticillium* and *Acremonium* species, the pathogenicity of which to insects needed clarification. *Bemisia tabaci* (the sweet-potato whitefly) was used as another insect host in this basic study. The *V. fusisporum* isolates originating from houseflies did not cause mortality in the homologous host, while different isolates of *V. lecanii*, *V. psalliotae* and *Acremonium* species caused high mortalities. However, none of the isolates had much effect within the first two weeks of incubation and thus do not seem to have potential for fly control, in contrast to some of the other species of Hyphomycetes that we have tested.

T. Steenberg and J. Brøchner Jespersen

7. Flies on pastured cattle

7.1 Biting midges on heifers

The Danish Veterinary Laboratory, Roskilde University Centre and Danish Pest Infestation Laboratory all participated in a project financed by the Ministry of Food, Agriculture and Fisheries and the Danish Environmental Protection Agency. The goal of the investigation was to monitor the effect of biting midges *(Culicoides spp.)* on grazing cattle. Two groups of five heifers each received regular treatments with synthetic pyrethroid compounds; two other groups of five animals each were not treated. All groups were grazing adjacent to a bog, known for many midges. A fifth group of five heifers was grazing at some distance, where no biting midges were present. During the grazing season 1998, recordings of weight, double skinfold thickness in the belly region as well as sampling of blood and faeces were performed on all the animals. The animals were slaughtered by October and pathology inspection and histopathology were performed on samples from belly and udder.

Light traps were used to determine the number of biting midges as well as the number of species. It was demonstrated that the exposure of the heifers to the midges was very low (5-10 times) in the summer of 1998 compared to previous years.

There was no statistically significant effect of the insecticide treatment on the growth rate of the animals. The experimental groups were significantly different regarding macroscopic lesions on the belly and udder at slaughter, but this could not be related to exposure to the midges. The presence of minor skin lesions was related to measurable serum levels of Tumor Necrosis Factor (TNF) on an individual animal basis. There were few changes in the investigated haematological and clinico-chemical parameters.

Due to the low erratic numbers of midges during the summer, it was not possible to relate the individual heifer's exposure to midges to the physiological parameters mentioned.

J. Brøchner Jespersen and K.-M. Vagn Jensen

7.2 Microbial control of flies on pastured cattle

This project aims to gain information on entomopathogenic fungi as potential candidates for microbial control of horn flies (*Haematobia irritans*), face flies (*Musca autumnalis*) and other fly species on pastured cattle. The survey of naturally occurring fungal pathogens in these fly species, started in 1997, was continued in 1998. Live flies were sampled from cattle at three locations on a weekly basis between July and September. As in 1997 the fungal prevalence was in general very low. However, in contrast to the first year of the survey we recorded not only hyphomyceteous fungi but also entomophthoralean fungi (*Entomophthora muscae*, *Furia* sp.) from hornflies, sheep head flies (*Hydrotaea irritans*) and stable flies (*Stomoxys calcitrans*). Transmission experiments including *E. muscae* and *E. schizophorae* were carried out with cattle flies as receptors, but no transmission was observed. The low field prevalence and the low susceptibility in the laboratory of cattle flies to fungal isolates from the *E. muscae* complex indicate that these fly species are not likely to be controlled naturally by this group of fungi.

As in 1997 we recorded epizootics of *E. muscae* in other flies present in the pastures. Fungus-killed cadavers were found at two locations and like the previous year the cadavers were almost exclusively found attached to the upper part of thistles. Whereas the dominant fly species in 1997 in these epizootics was the muscid *Phaonia perdita*, in 1998 it was the yellow dungfly (*Scatophaga stercoraria*). The identity of the fungi involved is not yet clear. The *E. muscae* in *P. perdita* (1997) had very large conidia which contained more nuclei than any species previously described from the species complex. The *E. muscae* in the yellow dungfly (1998) had conidia with 15-18 nuclei on average and may correspond to *E. scatophagae*, a species that is only separated from the complex with difficulty, mainly based on its specificity to yellow dungflies. However, we have shown that the fungus can easily be transmitted from yellow dungflies to houseflies. The work with the identification of these fungi will continue, but in future the project will focus on infection experiments with hyphomyceteous fungi as microbial control agents of cattle flies.

T. Steenberg, K.-M. Vagn Jensen and J. Brøchner Jespersen

7.3 Manipulation of fly-load on heifers

The Department of Biological and Ecological Chemistry, IACR-Rothamsted, UK, The Laboratory for Behavioural Physiology, Institute for Animal Science and Health, NL and the Danish Pest Infestation Laboratory all participated in a project financed by the EEC. The project was presented as a poster at the 9th International Congress on Pesticide Chemistry held in London 2-7 August. The overall goal was to find new ways to control dipteran pests on cattle. Current control measures rely heavily on the use of synthetic insecticides. Due to a build-up in resistance to insecticides and public concern for the environmental impact, alternative methods of control based on the use of semiochemicals are being investigated. Studies on cattle/fly interaction have revealed differences in fly-load between individual heifers within herds, which have been attributed to differences in volatiles produced by the host. A new approach of pest control, using cattle derived semiochemicals as part of a "push-pull" strategy, is therefore being developed. The feasibility of this approach was demonstrated by an experiment on two herds, each including cattle with different fly-loads. By moving susceptible and less susceptible cattle between the two herds, it was possible to re-distribute the fly population in both. Volatiles emitted by susceptible and less susceptible cattle were collected by means of air entrainment techniques and analysed by coupled GC-EAG and GC-MS. Of the eighteen EAG-chemicals identified, only 1-octen-3-ol and m-/p-cresol have previously been identified as semiochemicals influencing dipteran host location. One newly identified compound in particular, 6-methyl-5-hepten-2-one, elicited high EAG and behavioural activity. Preliminary field trials with this compound applied to two individuals in a herd resulted in a significant re-distribution of the fly-load within the whole herd.

K.-M. Vagn Jensen and J. Brøchner Jespersen

8. Cockroaches

8.1 Entomopathogenic fungi for control of *Blattella germanica*

In the final year of this project focus was put on transmission studies with selected fungal pathogens and on the importance of high humidity for fungal infection of German cockroaches. Non-choice experiments in which fungal spores were applied to water tubes showed that this was a potential means of transmitting inoculum of *Paecilomyces fumosoroseus* and *Metarhizium anisopliae* to cockroaches. However, the infection rate was low, and it is not yet known whether cockroaches are able to detect the fungal spores and thus avoid fungus contaminated water tubes in choice situations. A number of transmission studies included live, fungus-inoculated cockroaches or sporulating cadavers placed in the harbourages. It was shown that it was possible to transmit *M. anisopliae* within the cockroach populations, although the mortalities never reached the high mortalities reached in previous infection experiments (Annual Report 1996). *Paecilomyces fumosoroseus* did not spread among cockroaches in these experiments.

Previous infection experiments were conducted at very high relative humidity (RH) in order to optimize the effect of the entomopathogenic fungi. We showed that the best effect of the fungi was obtained at 100% RH during the first day after inoculation of the cockroaches. An RH of 85% limited the effect of the fungi, even though it was still possible to infect cockroaches under these conditions. Based on these results it can be concluded that RH in cockroach harborages will not always be optimal for germination and sporulation of fungal pathogens.

T. Steenberg and K.-M. Vagn Jensen

9. Fleas and lice

9.1 Fleas

9.1.1 Fipronil as a systemic insecticide in a rodenticide bait for flea and rat control

In a series of tests with three different concentrations of the insecticide fipronil in a rodenticide bait with bromadiolone for a combined control of the plague flea *Xenopsylla cheopis* and the rodent host *Rattus rattus* it was found that fipronil is an effective insecticide for the purpose. There were, however, some palatability problems with the bait used in the test. For further details see Chapter 13.

K. Søholt Larsen, H. Leirs and J. Lodal

9.2 Lice

9.2.1 Questionnaire investigation on headlice

During the last years there have been increasing problems with headlice among school children and children in child care institutions. In 1998 the Danish Pest Infestation Laboratory initiated a questionnaire investigating headlice in Denmark. The investigation was directed at pharmacies, schools' health care professionals and at parents of children in schools and child care institutions. The purpose of the investigation was to achieve a better knowledge about the number of children infested with headlice, which children are infested, and how information about headlice is given and to whom.

All pharmacies and school health care systems in Denmark received a questionnaire, and parents of children in especially selected schools and child care institutions in Copenhagen and Silkeborg have been asked to participate in the investigation. In all 2,020 questionnaires have been distributed.

The questionnaire investigation about headlice is so far the most comprehensive investigation in Denmark and is expected to be finished in 1999. The investigation is economically supported by a private company.

A. M. Rasmussen and K. Søholt Larsen

10. Arthropod pests in poultry production

10.1 Litter beetles

The litter beetles, *Alphitobius diaperinus* (the lesser mealworm), *Typhaea stercorea* (the hairy fungus beetle), *Ahasverus advena* (the foreign grain beetle) and *Carcinops pumilio* are commonly found in Danish poultry houses. These beetles are difficult to control and often constitute a pest problem. In addition they are potential transmitters of human and avian disease.

In 1996 the Ministry of Food, Agriculture and Fisheries supported a three-year 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), and many veterinarians and poultry meat farmers.

The project will conclude in 1999, but has already achieved most of its objectives. The principal findings made so far are detailed below.

A. Spencer and J. Brøchner Jespersen

10.2 The role of litter beetles in the transmission of disease

Fourteen broiler houses were non-randomly selected based on their salmonella infection status. Nine were persistently contaminated with salmonella while the remaining five were salmonella negative.

In each house, beetles collected from two consecutive flocks and during the empty period between these flocks were monitored for the presence of salmonella and campylobacter.

Beetles sampled during production were shown to be able to harbour salmonella and/or campylobacter, confirming earlier studies in Denmark and elsewhere. More significantly however, in one house, beetles collected during the empty period were also found to be salmonella positive. This demonstrates the potential for litter beetles to transfer infections between successive flocks. However, our results also suggest that salmonella from beetles may not always be transmitted to the chickens and that beetles living in infected houses can remain free of infection.

All cases of campylobacter positive beetle samples were detected in connection with a positive chicken flock. In no case was campylobacter isolated from beetles taken from an empty house.

This work was carried out in collaboration with M. N. Skov, L. Petersen and M. Madsen of the Danish Veterinary Laboratory, Århus. The findings will shortly be submitted for publication. All bacterial analysis was carried out by collaborators at DVL, Århus.

A. Spencer and J. Brøchner Jespersen

10.3 A survey of litter beetles in Danish broiler houses

Samples were collected from 16 beetle infested broiler houses using two trap types. Wall-traps consisting of netting bags containing boiled wheat suspended against the outer wall out of reach of the chickens were found to be effective in collecting the fungus feeding species *Typhaea stercorea* and *Ahasverus advena*. Floor-traps made from sections of PVC pipe perforated with 4 mm holes, stoppered at each end and placed half-filled with chicken feed within the litter, were effective in collecting *Alphitobius diaperinus* and also collected *Carcinops pumilio*. Five of each trap types were placed in each broiler house for one week immediately prior to slaughter. The traps were then returned to the laboratory where the beetles collected were speciated and counted.

A. diaperinus was the most prevalent species and was found in all the houses surveyed. *T. stercorea* and *A. advena* were also common and were found in large numbers in many houses. No other beetle species were identified.

A. Spencer and J. Brøchner Jespersen

10.4 Entomopathogenic fungi for control of litter beetles

This was the final year of the project, aimed at evaluating the potential of entomopathogenic fungi for the control of the lesser mealworm in poultry houses. In the laboratory we have selected a number of fungal isolates with high pathogenicity to larvae or adult beetles. The field efficacy of these isolates should be tested in the future. Planned experiments with application of fungus in bait stations were abandoned, as initial experiments showed that is was very difficult to attract the pest into the bait stations when placed under realistic conditions, i.e. in substrates providing alternative hiding places for larvae and adults. During 24 hours 5-10% of late-instar larvae would enter the bait stations, and the experiments indicated that the larvae were attracted to the stations primarily because they provided a hiding place, while the food provided (boiled wheat kernels or a solid substrate consisting of corn flour, wheat bran, dry yeast, water and agar) was not very attractive. It should be evaluated whether the selected fungal isolates can control the lesser mealworm by spreading in the population after 5-10% have been inoculated in bait stations. Furthermore, other food sources should be evaluated as baits.

T. Steenberg and J. Brøchner Jespersen

10.5 Insecticide use and resistance in beetles infesting broiler houses in Denmark

A survey of Danish broiler producers was conducted by way of a detailed questionnaire to ascertain the prevalence of litter beetle infestation, and the control measures used to manage them. A total of 177 questionnaires were returned completed and are included in our analysis. This represents approximately 54% of Denmark's broiler producers.

Almost 60% of those responding reported litter beetle infestation. Of these 76% used insecticidal treatments. A wide variety of insecticides were used, with organophosphates being the most popular one. In spite of the persistence of most infestations, all but one of the respondents reported good or moderately good effect from insecticidal treatment. However, in visits to infested farms soon after treatment we have often found large numbers of apparently unaffected beetles.

We are therefore currently carrying out a survey of insecticide resistance on litter beetles collected from infested farms. This study involves a range of insecticides including organophosphates, carbamates and pyrethroids. We plan to report on our findings in 1999.

A. Spencer and J. Brøchner Jespersen

11. Stored product pests

11.1 Official examination of consignments 1998

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 1998 a total of 814 consignments were examined: 169 grain lots, 104 lots of malt, 112 consignments of tobacco, 107 lots of dried peas and 322 consignments of other products, half of them being potato starch. Live insects were found in 1.5% of the consignments, mainly in grain lots. The following pest species were detected:

Number of lots	Pest species
8	*Sitophilus granarius*
3	*Ptinus tectus*
1	*Tribolium confusum*

L. Stengård Hansen

11.2 Allergens from pests in grain stores and milled products

C. Danielsen's Ph.D.-thesis, entitled "Population dynamics of *Lepidoglyphus destructor* (Schrank) (Acarina: Glycyphagidae) and its production of allergens in stored grain" was accepted by the University of Copenhagen on November 12, 1998.

L. Stengård Hansen

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

The purpose of this five-year project is to identify natural enemies that can be used to control *Ephestia kuehniella* in flour mills. The third year of the project focused on climate and pest monitoring in three mills, a series of trials to elucidate flour moth trap catches in relation to temperature as well as laboratory investigations of the two natural enemies that have been selected for this purpose.

Temperature and humidity conditions as well as the flour moth populations were monitored for a second year in two industrial flour mills and the programme expanded to include a smaller mill that processes organically produced grain. This information will be analysed to identify the conditions that lead to the increase in moth densities seen in the spring. It will furthermore be used in the process of evaluating the potential of natural enemies.

Laboratory investigations have been greatly disturbed by the presence of a pathogen, the protozoan *Mattesia dispora* (Gregarinida) in the *Ephestia kuehniella* colony. The following procedure seems to have taken care of the problem: the rearing medium (crushed wheat and dried yeast) is heat-treated at 105°C for 7 hours. Flour moth eggs for colony initiation are immersed in sodium hypochlorite (1%) for 10 minutes. All equipment is disinfected either by UV-sterilization or disinfective liquids.

Investigations on the biology of the egg parasitoid *Trichogramma evanescens* reared on *E. kuehniella* were initiated, starting with determination of the threshold temperature for activity. Single female parasitoids were placed at 5°C and observed. The temperature was raised in steps of 0.5°C until the parasitoid displayed walking activity. The mean threshold temperature was approximately 10°C (range 7.0°-13.0°C). Furthermore the effect of temperature on the development period of *T. evanescens* was studied. The investigations were carried out at 15°, 20°, 25° and 30°C. Developmental durations ranged from 33 days to 7 days at the temperatures used. A pilot study revealed that although some development occurs at 10°C (the parasitized eggs turn black and thus reach the third larval stage), no parasitiods emerge after 6 months at this temperature. Investigations on the fecundity, longevity and host feeding rate of *T. evanescens* were initiated late in the year and will continue in 1999.

The investigations of the predation rate of the predatory mite, *Blattisocius tarsalis,* on eggs of *E. kuehniella* have continued. The relationship between temperature, prey abundance and predation rate of adult female mites has been studied in the laboratory at temperatures of 15°, 21°, and 27 °C and with prey densities of 3, 5, 10, and 15 eggs per mite. At low prey densities (3 eggs per mite) each mite devoured 2 eggs, whereas at high prey densities (15 eggs per mite) 3-7 moths eggs were destroyed by each mite.

The percentage of flour moths eggs killed by the predatory mite decreased with increasing prey density. Investigations on the developmental rate and fecundity of *B. tarsalis* were also initiated and will continue in 1999.

The results of laboratory investigations on the effect of temperatures (12.5° to 30°C) on the proportion of flour moths caught in pheromone traps are now being analysed. The range of male moths caught in the traps was <1-47%, highest at 20°C.

L. Stengård Hansen, P. Sejerø Nielsen and H. Skovgård Pedersen

11.4 Implementation of IPM (Integrated Pest Management) in Danish flour mills

In the past the Danish flour mills have relied on a pest control strategy, which includes fumigation with methyl bromide, typically once a year, in order to prevent problems with various insect pest species. In Denmark the use of methyl bromide was prohibited on the 1st January, 1998.

This project has dealt with the insect pest control situation in three Danish flour mills. The purpose was to increase the knowledge of technically and environmentally acceptable prevention and control methods on insect pests in flour mills, at an acceptable price.

The present investigation shows that flour mills in Denmark have replaced methyl bromide fumigation by increased efforts in sanitation. By the use of regular shutdowns in production combined with cleaning, they have been able to manage pest problems. Danish flour millers continue to gain experience as to how to operate without fumigation with methyl bromide.

The two main pest species in the mills are the Mediterranean flour moth *Ephestia kuehniella* Z. and the confused flour beetle *Tribolium confusum* Duval. Other pest species are only causing local or minor problems, although these problems are sometimes of economic importance. Progress in the millers' handling of pest problems can be achieved, and this work yields the framework for further improvement of the IPM systems, without the reliance on methyl bromide fumigations.

P. Sejerø Nielsen

11.5 Investigation on the possibilities of using the IPM concept for pest control in Scandinavian flour mills

This project has dealt with the insect pest control situation in a Danish and a Norwegian flour mill. Both mills were large, handling above 100,000 tonnes of grain per year. The situation in Denmark and Norway was compared according to climate, structure of buildings, demands on hygiene, pest control procedures, etc. The use of IPM is believed to be a way of managing pest problems in flour mills without fumigations, and this investigation evaluated the present use. It can be concluded that the production conditions, climate and pest species in Denmark and Norway are very much the same, except that Norway is still using methyl bromide. Progress in the millers' handling of pest problems can be made and this investigation yielded a number of recommendations for further improvement of the IPM systems, without the reliance on fumigation with methyl bromide. It is concluded that IPM is a possible alternative to fumigation with methyl bromide.

P. Sejerø Nielsen

11.6 Ecological constraints and spatial distribution of an introduced agricultural pest, *Prostephanus truncatus*, in natural habitats of West Africa

The larger grain borer *Prostephanus truncatus* (Bostrychidae) is a wood dwelling insect that is able to develop on other dry plant material, e.g. stored maize and cassava. It was recently introduced into Africa and has become an economically important pest in large areas. In conjunction with ongoing activities conducted by the Stored Product Pest Management Group at the International Institute of Tropical Agriculture, Cotonou, Benin, a Ph.D. study was initiated in May 1998 to study certain aspects of *P. truncatus*'s ecology in woody habitats.

Tree species from forest and savanna areas were tested for their susceptibility to *P. truncatus* under lab conditions. As yet we have been unable to culture these beetles on either wood that was dead at the time of collection or on fresh wood. Moisture content and especially collection time have been found to be important for the reproduction success. The effect of the time of collection is probably associated with biochemical changes in the wood composition; wood samples will be subjected to biochemical analyses.

P. truncatus' flight activity is being monitored by the means of pheromone traps in three forest localities. In all localities, trap catches are linked to traps placed in the vicinity of grain stores adjacent to the studied forests, and grain stores are being sampled monthly to monitor insect densities and grain damage. Seasonal changes in trap catches are evident. Climate, storage practices and wood species composition are being evaluated as potential driving factors for the trap catch patterns. Special efforts are made in the Lama Forest where spatial trap catch analyses are being combined with phytosociological studies of the forest.

Histological studies of *P. truncatus* have led to the detection of intracellular endosymbionts, which are being described. Laboratory experiments have shown that the organs harbouring these endosymbionts (mycetomes) were significantly smaller in females reared at higher temperatures. It therefore seems reasonable to assume that in certain Guinea Savanna areas daily temperatures can reach levels which may affect the mycetomal development and possibly the reproduction rate. This is being examined under laboratory conditions.

C. Nansen and L. Stengård Hansen

12. Various other arthropods

12.1 The effect of low oxygen pressure on museum pests

In order to find time threshold values for nitrogen treatment of museum pest insects, screening tests have been performed on *Anthrenus museorum* (eggs), *A. verbasci* (eggs), *Attagenus woodroffei* (larvae), *Att. smirnovi* (eggs and larvae), *Trogoderma angustum* (eggs), *Ptinus tectus* (imagines) and *Tineola bisselliella* (eggs). The specimens were exposed to 0.3% oxygen (balance nitrogen) at 25°C and 55% RH for exposure times in the range 6-72 hours. The most susceptible species/stage was *Att. smirnovi,* egg stage, where no survival was found. The most tolerant species/stage was *Att. woodroffei*, larval stage, where survival occurred after 72 hours.

The investigations are carried out in collaboration between the DPIL, PREMAL, Sweden (J.-E. Bergh) and the Danish Technical University (P. V. Nielsen). Since May 1999 the project has been a part of the EU project ”Save Art”.

L. Stengård Hansen

13. Rodents

13.1 Efficacy and palatability testing

13.1.1 Bromadiolone liquid poison

As a continuation of tests carried out previously and briefly described in Annual Report 1997 two room tests were conducted with a new formulation of a bromadiolone liquid poison against brown rats (*Rattus norvegicus*). No rats died in the two groups of ten rats after a four-day test period with a choice between the bromadiolone poison and non-poisonous tap water. Based on the calculated theoretical amounts of bromadiolone consumed per kg body weight at least one rat should have died in one of the tests.

J. Lodal

13.1.2 Alphachloralose

At the request of a Danish company a new paste formulation of 4% alphachloralose was tested on house mice (*Mus musculus*). Single-cage choice tests with organic crushed wheat as non-poisonous alternative to the alphachloralose paste gave lower mortality when tested on *M. m. musculus* than on *M. m. domesticus*. Room tests with a similar choice gave only minor differences in mortality. The difference in reaction is now under further study. This paste formulation was approved for control of mice inside and around buildings.

J. Lodal

13.2 Resistance to anticoagulants

13.2.1 Resistance in the brown rat

During 1998 about 1000 brown rats (*R. norvegicus*) were received for anticoagulant resistance testing. New municipalities where resistance has been found are: coumatetralyl in Præstø, Zealand, and difenacoum in

Vordingborg, Zealand. Decreased susceptibility to difenacoum was seen among rats from the municipality Nordborg in southern Jutland.

J. Lodal

13.2.2 Population effects of anticoagulant rodenticide resistance in brown rats

Resistance to anticoagulant rodenticides has pleiotropic effects that can decrease the fitness of resistant rats compared to non-resistant rats, when anticoagulants are no longer used. Thus, it can be hypothesized that resistance will disappear from the population if no anticoagulants are being used. In order to investigate this, a Ph.D.-project was started in 1998 with experimental populations of resistant rats that were established with wild rats trapped in two localities in Denmark. These populations will be submitted to treatments with or without anticoagulant rodenticides, in order to investigate how the prevalence of resistance will change over time and how the resistance genes spread through the population.

Resistance in this project is determined by the use of the Blood Clotting Response (BCR) test. With microsatellite markers it will be possible to measure an individual's reproductive success and thereby its fitness in relation to its state of resistance and to estimate changes of genetic composition due to the environmental selection over successive generations. A preliminary screening identifying polymorphic micro-satellite markers has been done. The molecular work is conducted at the DNA-laboratory, Department of Population Biology, University of Copenhagen.

A.-C. Heiberg

13.3 Other works on rodents and rodent management

13.3.1 Field voles *Microtus agrestis* and predation

Field work and data collection for the Ph.D. project “The effect of predation on field vole *Microtus agrestis* populations in fragmented forest habitats” was finished in the late spring of 1998. Twelve experimental trapping grids in young beech or oak forests have been the fundamental basis for the project. Four of the grids have been covered with net to exclude raptors, owls and foxes, four other grids were predator-enriched by the setting up of perches and nest boxes for owls and kestrels, and the four remaining grids were left unmanipulated as control grids. Bank vole *Clethrionomys glareolus* and common shrew *Sorex araneus* have to some extent been incorporated in the study because they occurred in reasonable numbers and both species are relevant as prey items. As a supplement some laboratory experiments with voles and odours of predators formed part of the project too.

Survival. In response to predator exclusion the subadult winter survival in populations of *Microtus agrestis* increased in forest clearings. There were no significant results on adult survival in the reproductive season. The increased winter survival led to generally higher population sizes on predator exclusion grids, especially in the non-reproductive season. Throughout the year the relative changes in population sizes were density-dependent.

Winter survival was significantly correlated with both the relative change in population size and spring population size. Survival was not correlated with November population size, but together with immigration, which showed density dependence, it may shape the negative correlation between November population size and the relative change in population size. The results indicate that predation, though not the only factor of importance, has a major influence on survival, which, despite showing only weak signs of density dependence, is a key factor in shaping population size changes and spring population size.

Predator exclusion seems to have a positive influence on the proportion of females in the population over winter. Female proportion in spring was significantly positively correlated with survival. Spring weights on the other hand do not seem related to survival.

Body weight. The effect of predation risk on body weight in subadult *Microtus agrestis* was studied in the laboratory and in the field. The exposure of voles in the laboratory to faecal odours from domestic cat, captive fox and captive mink led to a larger decrease in individual body weight compared to control voles when the distance between cover and food bowl was short, despite equal intake of food in both groups of voles. An increase in the distance between cover and food bowl to 50 cm resulted in very low food intake in voles exposed to predator odour compared to control voles. In the field, voles from grids where mammalian and avian predators were excluded generally lost less or gained more weight in autumn and winter than voles from corresponding control grids. Despite some variation in individual weight changes during autumn and winter voles from exclosures gained more weight than control voles in early spring immediately before the onset of reproduction. Mean weights throughout autumn, winter and spring were found to be affected not only by individual weight changes but also by immigration. When immigration was low, mean weights on predator exclusion grids were higher than on predated grids. Accordingly, the result of reduced predation risk in the laboratory as well as in the field seems to be higher body weight in the individual and often also in the population. In the field this was especially evident at the onset of breeding in spring, potentially resulting in a higher reproductive potential. To our knowledge this study is the first of its kind to show the same trend in weight development in the laboratory as well as in the field.

Reproduction. A reduction in predation in populations of *Microtus agrestis* in forest clearings led to earlier onset of reproduction on the predator exclusion grid at one site whereas there was no effect at another site. A possible connection between onset of reproduction and body weight was found.

A higher proportion of pregnant females was found on predator-excluded grids than on predated grids in spring. Mean litter size was almost similar on all grids. Litter size was positively correlated with body weight. There was no treatment effect on any reproductive parameter in spring that could not be ascribed to a treatment effect on body weight.

During summer, however, selective predation on pregnant females could be an explanation for the lower proportion of pregnant females found on a control grid compared to the neighbouring predator exclusion grid. Probably as a result of the higher proportion of pregnant females late summer recruitment of immatures and juveniles was higher on the predator-excluded grid.

Forest habitat types. It was also investigated how different habitat types in a Danish forest affected survival, body weight and reproduction of *Microtus agrestis*.
Three donor habitats and one reception habitat were distinguished. A fifth habitat included small patches of donor habitat, induced donor habitat and reception habitat in otherwise closed forest without undergrowth. Recorded movements of individual field voles indicated that one continuous population of field voles spanned over the three donor habitats whereas the patchy habitat and the reception habitat were isolated from the

donor habitats by habitat barriers. The three donor habitats were a perennial grassland, a young spruce plantation and a mature, open, mixed forest.

In the dry summer of 1997 population size and recruitment rate peaked earlier in the moist and shaded patchy habitat than in the perennial grassland where the food supply dried out.

In the donor habitats in the warm winter of 1997/98 the field voles in the perennial grassland gained more weight and reached higher mean weights than the voles in the mature forest, whereas these latter voles had a higher survival probability. The voles in the young spruce plantation took an intermediate position in both respects. It is suggested that predation causes the lower survival of the grassland voles, but that negative effects of predation on body weight are compensated for by a favourable food situation. In the mature forest low predation may have caused the higher survival probability. The reduction of negative effects on body weight from predation risk, however, could not compensate for a poor food supply.

The onset of reproduction happened earlier in the grassland than in the young spruce plantation and in the mature forest, probably because of higher body weights in the grassland.

Bank voles. The effect of predation and predation risk on survival, body weight development and microhabitat preferences of temporary non-breeding populations of bank voles *Clethrionomys glareolus* was investigated in two forest clearings in the autumn of 1996.

Female bank voles were found to be influenced to a higher degree than males. Female survival was higher on predator-excluded grids compared to predated grids, whereas there was no clear response in males.

Females also gained more weight on predator-excluded grids compared to both males on the same grids and females on predated grids. There was no clear treatment effect when mean body weights were compared in each trapping period. However, mean female body weights on net grids were significantly higher in November than in September. This was not the case on predated grids.

There was a clear treatment effect on female microhabitat preferences. On predated grids female bank voles were captured at trap stations with more cover than females on net grids. A similar but less clear tendency was seen in males. On both net grids in both trapping periods female bank voles were trapped at trap stations with less cover than males, whereas the opposite was true for both predated grids in both trapping periods.

Shrews. In a predator exclusion experiment in the field only slight treatment effects were found on population size, mean body weights and microhabitat choice of common shrew *Sorex araneus*. However, changes in mean body weight were clearly affected by predation. Higher relative decreases in mean body weight with higher initial weights on non-excluded grids may reflect that heavy shrews reduce predation risk by inactivity thereby losing weight, whereas light weight shrews are forced to remain active. On predator exclusion grids there were higher relative decreases in mean body weight the lower the initial weights were. The mean body weight also had an effect on microhabitat choice. On non-excluded grids there was a negative correlation between cover and body weight, whereas the opposite was true for exclusion grids. Microhabitat choice was further and more clearly affected by the presence of microtines. On non-excluded grids high numbers of voles were correlated with low degree of cover for shrew captures. There were indications that shrews and voles avoid one another. Voles show increased preference for cover on non-excluded grids. This probably leads to less covered space available for shrews. On predator exclusion grids where voles show less preference for cover there was no correlation between degree of cover for shrew captures and vole numbers.

M. Carlsen and J. Lodal

13.3.2 Behavioural response of field voles under mustelid predation risk in the laboratory

Several studies have tried to investigate the indirect influences of predator presence on prey animals. In this study we focused on the time budgets around feeding behaviour by observing the behaviour of 24 field voles *Microtus agrestis* (Linnaeus, 1761) in the laboratory, exposed to no odour, faeces from a least weasel *Mustela nivalis* (Linnaeus, 1766) and faeces from a domestic rabbit *Oryctolagus cuniculus* (Linnaeus, 1758). The voles showed a response when exposed to weasel odour, while exposure to rabbit odour did not cause any effects. The lack of a clear response to rabbit odour rules out neophobia as the underlying cause of the behavioural changes. Voles exposed to weasel odour were more inactive, ate less of a high preference food which was placed far from the nestbox, displayed a smaller variation of behaviour types and were overall more abrupt in their actions. The study confirmed that the mere risk of predation affects voles' feeding behaviour. This may explain indirect effects of predation risk on other processes like reproduction.

This work resulted in an M.Sc.-degree for Thomas Bolbroe, University of Copenhagen.

T. Bolbroe

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

The research on population ecology of *Mastomys natalensis* rats continued with the further analysis of earlier field data and the development of a population dynamics model. It was further intensified by the start-up of two Ph.D.-projects in Tanzania.

The Ph.D. project "Predation pressure and population dynamics in African *Mastomys* rats: possibilities for integrated pest management?" started in November 1997. Data collection is carried out at Sokoine University of Agriculture in Morogoro, Tanzania. Ten study fields are cultured as maize fields according to local custom. Each field plot of 0.5 ha has been ploughed and constructed according to one of the following predation manipulations:

(1) Predators excluded (by nets)
(2) Predators allowed (control)
(3) Predators attracted (by perch poles and nest boxes)

To verify any masking effects of the treatment by rodent dispersal (i.e. immigrating and emigrating), the treatments are supplied to plots where the rodent populations are enclosed (migrations not allowed; closed population) as well as to open plots where the rodent populations have no physical barriers (migrations allowed; open population). For the areas with predator attraction, only open populations are used. All treatments are replicated.

Capture-recapture experiments on the rodent population have been carried out since March 1998. In the two predation areas, and in the two open control population areas, observations on birds of prey have been carried out twice during each capture-recapture session since the beginning of June 1998. Since the beginning of April 1998, owl pellets have been collected once a week under trees in the surroundings of the predation areas as well as under perch poles. Following harvest of maize, cob damage is estimated by weighing the total amount of shelled corn on each area. The project continues until the end of October 2000.

A second study, ”Population dynamics of *Mastomys natalensis* in different habitats: an experimental and modelling study” is undertaken as a Ph.D.-study at the University of Antwerp (Belgium) with supervision from DPIL. The population dynamics of these rats are investigated in capture-recapture set-ups on a 3 ha field-fallow mosaic and a 1 ha maize mosaic. Recolonization of maize fields after control is studied on a set of additional experimental maize fields. The field work continues with monthly captures until mid-2000.

H. Leirs and S. Vibe-Petersen

13.3.4 Palatability and toxicity tests of fipronil as a systemic insecticide in a rodenticide bait for rat and flea control

Vector/reservoir control in plague endemic areas must target rodents as well as their flea ectoparasites. Traditionally, insecticides are dusted before the application of rodenticides or an insecticide powder is applied in a bait box where rodents enter to reach the rodenticide. Both methods have their logistic problems. We investigated the possible use of fipronil as a systemic insecticide to be mixed in a anticoagulant rodenticide bait.

Three different concentrations of fipronil (0.05%, 0.005%, 0.0005%, with acetone as a solvent and 0.05% with propylen glycol as a solvent) and two control solutions (solvents only) were combined with a rodenticide bait consisting of crushed organic wheat and 0.005% bromadiolone. Each concentration was offered together with an unpoisoned alternative bait (crushed organic wheat) to ten singly caged *Rattus rattus*. One hundred rat fleas *Xenopsylla cheopis* were placed in each rat cage one day later.

Consumption of both choice baits was monitored daily for four days, after which the rats received unpoisoned standard food. Fleas were removed after six days and kept in a glass tube with sand; flea mortality was checked 24 and 48 hours later. Rodents were observed for 3 more weeks and rodent mortality was checked. All dead rats were autopsied for signs of anticoagulant poisoning.

Bait consumption was relatively low and an unsatisfactory rat mortality of around 50% only was obtained in all tests. The palatability of the bait, however, was not affected by the fipronil concentration although the solvents may have an effect. Flea mortality after 48 hours reached 100% at the highest fipronil concentrations and was still above 95% at the lowest concentration; in the control tests, the natural mortality was below 70%. In conclusion, fipronil has no bad effects on rodent bait palatability and is effective as a systemic insecticide to kill fleas. The bait base, however, has to be more attractive to roof rats in order to be useful in practice.

K. Søholt Larsen, H. Leirs and J. Lodal

13.3.5 Effects of grazing on small mammals in wet meadows

Differences in vegetation structure affect living conditions for small mammals, with respect to food quality and quantity, cover against predators, etc. In the framework of a large project to investigate the different grazing systems as a nature management strategy, DPIL and the Royal Veterinary and Agricultural University (Copenhagen) investigate the population ecology and behaviour of rodents under different grazing pressure. The experimental areas are situated in Fussingø, Jutland, and subject to different grazing and/or mowing intensity by sheep or cattle. On six of these areas, a capture-recapture study with monthly trapping was started in June 1998. The data collection will continue for two years.

H. Leirs

14. 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
Dermanyssus gallinae	Kyllingemide
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
Stomoxys calcitrans		Stikfluen
Siphonaptera	**Lopper**	
Ctenocephalides felis		Katteloppe
Xenopsylla cheopis		Tropisk rotteloppe
MAMMALIA		**PATTEDYR**
Apodemus sylvaticus	Skovmus	
Apodemus flavicollis	Halsbåndmus	
Mastomys natalensis	Afrikansk gnaver	
Mus musculus/domesticus [3,1]		Husmus (lys og mørk)
Rattus norvegicus		Brun rotte
Rattus rattus		Husrotte

15. Publications and reports

15.1 Publications by members of staff in 1998

Birket, M., J. A. Pickett, L. J. Wadhams, C. M. Woodcock, H. Joop Prijs, G. Thomas, J. Trapman, K.-M. V. Jensen and J. B. Jespersen, 1998: Control Of dipteran pests of cattle: Development of a push-pull strategy *in* Proceedings from the 9th International Congress on Pesticide Chemistry, London 2-7 August 1998, 1.

Carlsen, M., 1998: Survival in *Microtus agrestis* in a predator exclusion experiment. Abstracts, Euro-American Mammal Congress, July 19-24, 1998, Santiago de Compostela, Spain, p. 310.

Danielsen, C., 1998: Population dynamics of *Lepidoglyphus destructor* (Schrank) (Acarina: Glycyphagidae) and its production of allergens in stored grain. Ph.D. thesis, University of Copenhagen, 75 pp.

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, pp. 11-17 *in* Gomez, C. & Sandoval, E.V. (eds): Pesticide Resistance in Horticultural Crops. Fudacion para la Investigacion Agraria an la Provincia de Almeria, 117 pp.

Erichsen, L.D., 1998: Billers populationsdynamik i slagtekyllingestalde (Populationdynamic of litter beetles in broiler flocks). Master of Science Thesis, Copenhagen University, 58 pp.

Hansen, L. S., 1998: Prospects for developing strategies for biological control of the Mediterranean flour moth *Ephestia kuehniella* in flour mills. Pp 33-37 *in* Adler, C. & M. Schoeller (eds.): Proceedings Meeting Working Group on Integrated Protection of Stored Products, Aug. 31-Sept. 2 1997. Zürich, Switzerland. Bull. IOBC/WPRS **21**(3), 173 pp.

Hansen, L.S., 1998: The common furniture beetle *Anobium punctatum* in Danish churches - pest densities and moisture contents monitored for three years. Pp 130-138 *in* Proceedings 3rd Nordic Symposium on Insect Pest Control in Museums, Stockholm, Sweden, September 24-26, 1998, 179 pp.

Hansen, L.S. and K.-M. V. Jensen, 1998: Heat treatment of the common furniture beetle *Anobium punctatum* (Coloeoptera: Anobiidae) at temperatures between 45° and 54°C - under dry and humid conditions. Pp 36-41 *in* Proceedings 3rd Nordic Symposium on Insect Pest Control in Museums, Stockholm, Sweden, September 24-26, 1998, 179 pp.

Jensen, K.-M. V. and L. S. Hansen, 1998: Evaluation of chemical methods for prevention of damages to textiles due to Dermestidae and *Tineola bisselliella* (Lepidoptera: Tineidae). Pp 112-119 *in* Proceedings 3rd Nordic Symposium on Insect Pest Control in Museums, Stockholm, Sweden, September 24-26, 1998, 179 pp.

Jespersen, J. B. and K.-M. V. Jensen, 1998: Fluer og myg: ektoparasitter i Husdyrbruget *i* Parasitær Økologi, Jørn Grønvold (ed.): 151-168.

Kristensen M., V. Planchot, J. Abe and B. Svensson, 1998: Large-scale purification and characterization of barley limit dextrinase, a member of the α-amylase structural family. Cereal Chemistry **75** (4): 473-479.

Larsen, K. S., H. Leirs and J. Lodal, 1998: Palatability and toxicity tests of fipronil as a systemic insecticide in a rodenticide bait for rat and flea control. Acta Parasitológica Portuguesa **5** (1), 32.

Larsen, K. S. og A. M. Rasmussen, 1998: Fri os fra lopperne. Råd og Resultater **10:** 2-4.

Mortensen, T. S. and T. Steenberg, 1998: The potential of entomo-pathogenic nematodes as biological control agents of *Typhaea stercorea* (L.)(Coleoptera: Mycetophagidae) in broiler houses. IOBC Bulletin **21**(4): 197-202.

Nansen, C. , H. S. Pedersen and K. S. Larsen, 1998: Når kemien passser. Naturens Verden **3:** 81-88.

Nielsen, P. S., 1998: *Blattisocius tarsalis* (Berlese) Would this predatory mite be effective against moth eggs in Scandinavian flour mills? Pp. 83-87 *in* Adler, C. & M. Schoeller (eds.): Proceedings Meeting Working Group on Integrated Protection of Stored Products, Aug. 31-Sept. 2 1997. Zürich, Switzerland. Bull. IOBC/WPRS **21** (3), 173 pp.

Nielsen, P. S., 1998: Efficacy of a diatomaceous earth formulation on the larvae of *Ephestia kuehniella* Zeller. J. Stored Prod. Res. **34** (2/3): 113-121.

Nielsen, P. S. and H. Mourier, 1998: Skadedyr i Melmøller. Mider og insekter. Forebyggelses- og bekæmpelsesmetoder. Statens Skadedyrlaboratorium. CTH Grafisk A/S, 17 pp.

Pedersen, H. Skovgård and L. S. Hansen, 1998: Biological control with parasitic wasps at the Danish Pest Infestation Laboratory. Fødevareministeriet, 3 pp.

Rasmussen, A. M. og K. S. Larsen, 1998: Hovedlus. Ugeskrift for Læger **160/42-98**: 6057-6060.

Riedel, W. and T. Steenberg, 1998: Adult polyphagous coleopterans overwintering in cereal boundaries: winter mortality and susceptibility to the entomopathogenic fungus *Beauveria bassiana*. BioControl **43:** 175-188.

Svendsen, Tina S., 1998: Susceptibility of the hairy fungus beetle *Typhaea stercorea* (L.)(Coleoptera: Mycetophagidae) to four entomopathogenic nematode species (Rhabditida: Steinernematidae, Heterorhabditidae) in different substrates and suitability of the beetle for nematode propagation. Master of Science Thesis, Copenhagen University, 52 pp.

Storm, J. and O. Kilpinen, 1998: Modelling the subgenual organ of the honeybee, *Apis mellifera*. Biol. Cybern. **78:** 175-182.

Steenberg, T. and J. B. Jespersen, 1998: Microbial pest control in animal husbandry. IOBC Bulletin **21**(4): 25-29.

Steenberg, T. and K.-M. V. Jensen, 1998: Entomopathogenic fungi for control of German cockroach (*Blattella germanica*) and other synanthropic cockroaches. IOBC Bulletin **21**(4): 145-150.

Van Gulck, T., R. Stoks, R. Verhagen, C. A. Sabuni and H. Leirs, 1998: Short-term effects of avian predation variation on population size and local survival of the multimammate rat, *Mastomys natalensis*, (Rodentia, Muridae). Mammalia **62** (3): 329-339.

Vibe-Petersen, S., 1998: Laboratory rearing of the urine fly, *Scatella (Teichomyza) fusca*, and observations on feeding and oviposition on pig farms. Entomologia Experimentalis et Applicata **87**: 325-327.

Vibe-Petersen, S., 1998. Development, survival and fecundity of the urine fly, *Scatella (Teichomyza) fusca* and predation by the black dumpfly *Hydrotaea aenescens.* Entomologia Experimentalis et Applicata **87**: 157-169.

15.2 Appearances in the media

Larsen, K. S.: Headlice problems, DR Broadcasting, 18 January.

Larsen, K. S.: Headlice, Copenhagen Radio, 19 January.

Larsen, K. S.: Headlice problems, TV 2, 20 January.

Larsen, K. S.: Headlice problems, TV 3, 20 January.

Larsen, K. S.: Headlice problems in Græsted, Copenhagen Radio, 5 February.

Larsen, K. S.: Headlice problems in Græsted, TV 2 Lorry, 16 June.

Larsen, K. S.: Headlice problems, TV 2, 25 September.

Lodal, J.: Rats, damage caused by rats and rat control, TV Ishøj, 12 October.

Lodal, J.: Rats, rodenticides and resistance, DR TV1, 28 October.

Lodal, J.: Mice, traps for mice and other ways of controlling mice, Danish Broadcasting, 5 November.

15.3 Unpublished reports on laboratory tests and/or field trials

The reports are confidential except those marked *

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

4-1998 Lodal, J.: Laboratorieforsøg med 0,01% bromadiolon drikkegift mod brun rotte (*Rattus norvegicus*), 4 pp.

5-1998 Lodal, J.: Laboratorieforsøg med alphachloraloseholdig pasta mod mus, 32 pp.

*6-1998 Jespersen, J. B.: Retningslinier for fluebekæmpelse på gårde med husdyr i 1998, 7 pp.

7-1998 Larsen, K. S., H. Leirs and J. Lodal: Palatability and toxicity tests of fipronil as a systemic insecticide in a rodenticide bait for rat and flea control, 37 pp.

8-1998 Lauridsen, M. K. and J. B. Jespersen: Field trial with Baycidal WP25 (triflumuron) against litter beetles, especially *Alphitobius diaperinus* (Panzer), in a Danish parent flock poultry farm, 47 pp.

9-1998 Nansen C. and M. Kristensen: Evaluation of an insect repellent wrist band Bug Ban Myggebånd against *Aedes* mosquitoes in Denmark, 6 pp.

1-1999 Kristensen, M., A. Spencer and J. B. Jespersen: Biochemical and toxicological analysis of CGA-293 in susceptible and resistant strains of the housefly *Musca domestica,* 24 pp.

2-1999 Kristensen, M. and J. B. Jespersen: Larvicidal efficacy of CGA-293 in tests with two susceptible strains of the housefly *Musca domestica,* 6 pp.

3-1999 Larvicidal efficacy of dicyclanil in tests with two susceptible strains of the housefly *Musca domestica,* 6 pp.

4-1999 Lauridsen, M. K., J. B. Jespersen and M. Kristensen: Field evaluation of Fipronil Fly-bait Gel for control of the housefly *Musca domestica,* 34 pp.

5-1999 Kristensen, M. and J. B. Jespersen: Larvicidal efficacy of dicyclanil in tests with three resistant strains of the housefly *Musca domestica*. (9 pp.)

6-1999 Jespersen, J. B. and M. K. Lauridsen: Laboratory evaluation of NAF granular formulations for control of the housefly *Musca domestica,* 14 pp.

16. Evaluation of the efficacy of pesticides

16.1 Formulations submitted for registration

According to the Danish Act on Chemical Substances and Products (No. 424 of 10 June, 1997), 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 1998, 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. We recommended that several formulations be approved, but in some cases we concluded that more documentation was needed, supplementary tests should be carried out, or we recommended that the formulation should for certain reasons not be permitted for the use requested. The registration authorities generally followed our recommendations.

In 1998 we 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 we suggested or required changes in the directions for use.

N. Bille

17. Formulations approved by the Danish Pest Infestation Laboratory as of 1 March 1999

Fortegnelse over bekæmpelsesmidler anerkendt af Statens Skadedyrlaboratorium 1. marts 1999

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 pr. 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 pr. 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	pyrethrin I & II piperonylbutoxyd	0.40% 2.00%	Aeropak
* Norway only			
Trinol Turbo jet mod fluer	pyrethrin I & II piperonylbutoxyd	0.40% 2.00%	Aeropak

Trade name	Active material	Conc.	Company

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-smøremiddel	methomyl muscalure	1.07% 0.04%	Mortalin
Trinol smøremiddel	propetamphos muscalure	6% 0.04%	AgroDan

Treated strips:

		g per strip	
Malure flueplader	methomyl muscalure	0.1111 0.0042	Mortalin

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

(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

Trade name	Active material	Conc.	Company

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.)

Trade name	Active material	g per tag	Company
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

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	propoxur	9.4%	Bayer

Trade name	Active material	Conc.	Company
til hunde			
til katte			

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

Trade name	Active material	Conc.	Company
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.)

Trade name	Active material	Conc.	Company
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

Trade name	Active material	Conc.	Company

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 (Midler til indendørs bekæmpelse af myg)

Electric heater with vaporizing mats
(Elektrisk varmeplade med rygetabletter)

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

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

Trade name	Active material	Conc.	Company
Brota Musekorn	bromadiolon	0.01%	Mortalin
MausEx-Duo	bromadiolon	0.01%	Trinol
Materialshop musekorn	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*) (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 29 products were approved by the Danish Pest Infestation Laboratory as of 1 March 1999. 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

Trade name	Active material	Conc.	Company

Konsulent i Rottebekæmpelse for Jylland, Langdalsvej 38C, 8220 Brabrand, or Peter Weile, Miljøstyrelsens Konsulent i Rottebekæmpelse for Øerne, Strandgade 29, 1401 København K.

(Følgende 29 produkter var pr. 1. marts 1999 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%)	*15 preparations*
Tracking powders (0.15%)	*2 preparations*
Paraffin blocks (0.0025-0.01%)	*11 preparations*
Concentrate (0.25%)	*1 preparation*

9 Formulations for control of the mole (*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)

RM Mosegrisefælden	Water vole trap		RM-Service

11 Device to prevent sewer rats entering buildings via waste pipes

Trade name	Active material	Conc.	Company

(Aggregat til forhindring af kloakrotters indtrængning i bygninger via faldstammer)

Rottestop	Steel section to be inserted into ordinary waste pipe		SR-Stål

List of companies
Firmafortegnelse

Company Firma	Address Hjemsted	Abbreviation used in chapter 17 Forkortelse anvendt i kapitel 17
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
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