

genera. Statistical analysis of the standard measurements at birth for the Mexican and Panamanian *Tylomys* populations did not reveal any differences at day one; therefore, the data were pooled. The standard measurements, in millimeters, for *Tylomys* were: total length, 134.1 ± 1.0 ; tail length, 50.0 ± 0.7 ; hind foot, 18.0 ± 0.2 ; ear, 8.5 ± 0.04 . For *Ototylomys* they were: total length, 119.5 ± 0.9 ; tail length, 47.1 ± 0.8 ; hind foot, 16.4 ± 0.2 ; ear, 9.4 ± 0.2 . *Tylomys* weighed 20.2 ± 0.3 gr ms and *Ototylomys* 10.2 ± 0.3 grams at birth. The least variance over time was observed in the length of head and body, without tail, and was therefore most valuable for comparisons of growth rates over time. At birth, *Tylomys* measured 84.3 ± 0.7 mm and *Ototylomys* measured 67.0 ± 3.2 mm. Head and body length of *Tylomys* from Mexico was 34.9 per cent of adult body length; those from Panama were 35.8 per cent and *Ototylomys* were 46.4 per cent of their adult body lengths. No statistical differences were found between males and females at birth for either genus.

For approximately 30 days after birth, the neonates of both genera adhere tenaciously to their mother's inguinal teats. Both *Tylomys*' and *Ototylomys*' young are precocial, with *Ototylomys* young being the more precocial. The greatest number of *Tylomys* were initially able to respond to loud noises between days 8 and 9 while the largest number of *Ototylomys* initially responded by day 2. Eye opening occurred for the greatest number between days 10 and 11 in *Tylomys* and day 6 for *Ototylomys*. Hearing preceded eye opening in all but four cases.

Tylomys from Mexico have attained 50 per cent of adult body length by day 14 and those from Panama between days 12 and 14. *Ototylomys* reach 50 per cent of their adult body length by day 2. Ninety per cent of adult body length is reached at 120 days in the Mexican *Tylomys* while the Panamanian group grew to 90 per cent of their adult body length by 116 days. *Ototylomys* grew to 90 per cent of their adult body length by 58 days of age.

Order No. 74-13,903, 47 pages.

THE "DISTRESS" CRY OF INFANT DEERMICE, *PEROMYSCUS*: PHYSICAL CHARACTERISTICS, SPECIFIC DIFFERENCES, SOCIAL FUNCTION

HUFF, Jane Netting, Ph.D.
Michigan State University, 1973

Isolated *Peromyscus* pups vocalize with rapid sets of ultrasonic squeaks. These sounds were recorded from pups of 8 different taxa in order to quantify species-specific characteristics and parameters showing developmental changes. The behavioral responses of adult female *Peromyscus* to recorded squeaks were tested to clarify the function of the calls.

Pups of *Peromyscus maniculatus bairdi*, *P. m. gracilis*, *P. polionotus*, and *P. leucopus*, were recorded from day 1 after birth until the average age of eye-opening. Pups of *P. californicus*, *P. melanophrys*, *P. m. nebracensis*, and *P. difficilis* were recorded when available.

Statistical analyses showed significant interspecific differences in the number of squeaks in a group of squeaks (set), the duration of individual squeaks, and in basic frequencies. The *P. maniculatus* subspecies showed similar mean basic frequencies (*bairdi* - 22.6 kHz, *gracilis* - 22.9 kHz, *nebracensis* - 23.7 kHz) as did *P. melanophrys* (22.8 kHz). Mean basic frequencies for *P. leucopus* and *P. polionotus* were higher (26.7 kHz and 31.4 kHz) while those for *P. californicus* and *P. difficilis* were lower (18.6 kHz and 19.9 kHz). These frequencies tended to rise with age.

Squeak duration differed significantly between the taxa from *P. polionotus* (0.13 sec.) to *P. m. gracilis* and *P. californicus* (0.15 sec.). Set duration did not differ significantly across the

groups. The number of squeaks per set for *P. m. bairdi* and *P. polionotus* (3.70) was significantly different from the mean for *P. m. gracilis* (4.05) and *P. leucopus* (3.15). These temporal parameters all decreased significantly in mean value over age.

Comparison of oscilloscope films and sonagrams demonstrated species-specific patterns of frequency and intensity modulation. Each of the taxa studied differed from the others in at least one quantifiable parameter and in its modulation patterns. These calls also showed characteristics which make sounds easy to locate, such as high frequencies, frequency and intensity modulation, redundancy, and sharp rise and fall.

The hypothesis that these calls might affect the behavior of a mother mouse, (1) by increasing her activity and stimulating her to search for a "pup-in-distress"; (2) by enabling her to efficiently locate a calling pup; and (3) by providing sufficient long-distance information for preferential responses to species, was tested with groups of mice in two modified open-field boxes. *P. m. bairdi* mothers were tested in a two-way box, for differential activation and preference for recorded squeaks of *P. m. bairdi* pups versus mechanical clicks and white noise. In terms of numbers of responses, correct choices, and distances traveled towards the mouse squeaks, the test and control groups preferred the squeaks to clicks or noise. Similar groups of *P. m. bairdi* and *P. leucopus* mothers preferred *leucopus* squeaks to white noise. But those test groups given a choice between squeaks of the two species showed minimal discrimination.

P. m. bairdi mothers showed accurate location of the source of squeaks from recordings of live pups in a fan-shaped test box. Responses to recordings were faster and more accurate than to live if first choices alone were considered but a mean of three choices showed no significant differences between responses to live pups and recordings.

These data are interpreted to mean that the squeaking of a pup dropped by a mother mouse moving a nest or fleeing a disturbance is both a necessary and sufficient factor in ensuring retrieval and survival. The sounds alert the mother mouse to the situation, allow her to locate the calling pup efficiently, thus reducing risks of searching in the open, and possibly even permit her to respond preferentially to her own species. The ontogenetic changes in the characteristics of the squeaks correlate with the decreasing amounts of maternal behaviors, possibly because of reduced stimulus effectiveness. Differences in the squeaks occur in temporal and physical parameters across ages and between species in *Peromyscus*.

Order No. 74-13,909, 223 pages.

THE ECOLOGY OF SOME METAZOAN PARASITES OF, AND THEIR EFFECT ON, SMALL STREAM FISHES AND FRY. [Available for consultation at the University of Waterloo Library]

KAKONGE, Sam Atwoki Kabyanga, Ph.D.
University of Waterloo (Canada), 1972

The ecology of some metazoan parasites infesting fishes and fry inhabiting a small stream was studied by regular sampling from January 1970 to January 1972. The specimens of fish examined included 19 species, mostly minnows (Cyprinidae) of which the common shiner (*Notropis cornutus*), the fathead minnow (*Pimephales promelas*), the brassy minnow (*Hybognathus hankinsoni*) and the creek chub (*Semotilus atromaculatus*) were the most common.

Emphasis was placed on an extensive investigation of all the metazoan parasites occurring in the stream fish community in regard to incidence, intensity, seasonality of life cycles, relative infestation in different species of fish and different microhabitats in the study area. Artificial infections were also

carried out wherever possible, mainly to assess fatal parasite levels for comparison with infestation levels observed in the field.

The Monogenea (*Gyrodactylus* spp.), the glochidia of various species of Pelecypoda and the metacercarial trematodes belonging to black spot (*Neascus* spp.), white grub (*Posthodiplosternum m. minimum* Hoffman (1958)) and visceral/brain flukes (*Ornithodiplosternum ptychocheilus* (Faust)) were numerous enough to permit analysis of their seasonal dynamics. Winter parasitaemias were specifically more diverse than summer parasitaemias, possibly suggesting a link with the glacial parasite fauna. In fact, most of the parasite groups abundant during summer were metacercarial trematodes whose definitive host is a bird, and could therefore easily be recent post-pleistocene invaders of temperate regions.

Surface and superficially-developing parasites were influenced more by seasonal effects (mostly temperature) than were parasites imbedded in tissue and protected from direct contact with the environment.

Termination of the parasitic period of glochidia occurred in spring, coinciding with the period when the stream fishes have been shown to be most active and are therefore potentially able to disperse the young mussels far and wide.

The seasonal intensity of fish infestation with metacercarial trematodes dropped sharply following the peak of infection in summer. The drop was most probably due to death of the heavily parasitised fish.

The intensity of infestation of fish with any group of parasites recovered in large numbers increased with the size of fish, possibly because of the greater surface area and, in some cases, the longer period of exposure to infection; but in the case of the black spot (*Neascus* spp.) and the white grub (*Posthodiplosternum m. minimum*) the intensity and incidence decreased in fish of very old age. The decrease appeared to be due to "natural" immunity, coupled with death of the heavily infested fish at an earlier age.

Mortality due to infestation probably exceeds 50% in fry and is caused mostly by metacercarial trematodes.

BIOSYSTEMATICS OF THE GRYLLOBLATTODEA. [To obtain a microfilm copy please order directly from the National Library of Canada at Ottawa]

KAMP, Joseph William, Ph.D.
The University of British Columbia (Canada), 1973

Supervisor: Dr. G. G. E. Scudder

The North American Grylloblattidae are either hygrophilic occupants of the alpine-subalpine or facultative cavernicoles of lava ice caves. The research indicates that the habitats preferred by *Grylloblatta* must be cold and moist but not wet. The preferred alpine-subalpine hypolithion was found to be beneath stones 50 to 150 cm. buried 20 to 50 cm. deep in the substrate. *Grylloblatta* also temporarily occupied glaciers, snow fields, rotting logs and borders of glacial springs. The optimum micro-climate in the alpine-subalpine habitats was within -3 to +6°C. with a humidity above 70 per cent. Humidity evidently governs the occupancy of the hypolithion more than temperature. The insect will not inhabit hypolithion with relative humidities less than 70 per cent, regardless of temperature.

The cavernicolous habitat for *Grylloblatta* is a micro-environment limited to a few ice caves in lava fields. Sufficient ice must be present to maintain a spring-to-fall temperature of -3 to +8°C. and over 80 per cent relative humidity. During the winter the ice cave is recharged with cold air below the tolerance of *Grylloblatta* at which time the insect inhabits the hypolithion.

The temperature preference of *Grylloblatta*, established in the laboratory, was between -3.5 and +5°C. at 90 to 99 per cent relative humidity, -2.2 to +4.5°C. at relative humidities between 70 and 90 per cent, and -1.1 to +1.6°C. at 50 to 70 per cent relative humidities. Temperature tolerance at humidities above 95 per cent ranges between -4 and +11°C. Four-hour exposure to +16°C. and one-hour exposure at -5.5°C. produces 50 per cent mortality. Lethal extremes were -8°C. and +23°C. All stages of the insect were found to be active year around with no dormant period. The mean freezing point depression of the hemolymph was measured at -0.98°C., therefore, the insect remains active in a supercooled state.

Twenty-six new populations were found during this research extending the distribution from the Yukon-British Columbia border to the southern Sierra Nevada of California. Five new species and three new subspecies are here described. The distributional data indicate the presence of four divergent groups characterized by isolated endemic populations or species. The present disjunct distribution and zoogeography have been fundamentally influenced by the geologic and climatic events of the late Pleistocene. Further, regional and sometimes highly localized volcanic activity during the post Pleistocene, the warm dry Hypsithermal period, and the re-birth of summit and cirque glaciers, commencing approximately 2500 years ago, have affected the distributional patterns of *Grylloblatta*. The recent zoogeography of the various species and populations in western North America is discussed.

A comparative lipid analysis of Grylloblattidae and six other insects from related orders, and with varying temperature preferences, shows differences in fatty acid composition. The composition in *Grylloblatta* is more like that in Dermaptera, but the affinity is as remote as is demonstrated in the numerical analysis. Analysis of *Grylloblatta* shows 65.8 per cent of the total fatty acids are unsaturated, 91 per cent of which have melting points below its maximum tolerated temperature. The data clearly indicate the low temperature adaptation of *Grylloblatta*; such composition is not seen in the warmer tolerance forms.

In a numerical analysis of 164 external and internal morphological characters in *Grylloblatta* and seven other related orthopteroïd insects, Dermaptera has the closest affinity to the *Grylloblatta*. The phenetic affinities and relationships of the *Grylloblatta*, as shown in the analysis, place the taxon at the ordinal level. The most acceptable systematic treatment of this group is as the order Grylloblattodea.

FINE STRUCTURAL ASPECTS OF DEVELOPMENT OF EIMERIA NINAKOHLIYAKIMOVAE IN CULTURED CELLS

KELLEY, Gary Lee, Ph.D.
Utah State University, 1973

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Development of *Eimeria ninakohlyakimovae* from intracellular sporozoites to mature first-generation merozoites was studied. Monolayer cell line cultures of ovine trachea, kidney, and thyroid cells were inoculated with sporozoites of *E. ninakohlyakimovae*. Cultures containing parasites were fixed at the appropriate number of days after inoculation and prepared for examination. Sporozoites, trophozoites, schizonts, and merozoites grown in cultured cells were examined with the electron microscope. Intracellular sporozoites had ultrastructural characteristics similar to those of extracellular sporozoites except that apparently functional micropores were observed. During transformation of sporozoites to trophozoites, the conoid, annuli, and subpellicular tubules, as well as some portions of the inner membrane complex of the pellicle, disappear.