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Observations on Distribution and Biology of *Phlebotomus* Sandflies from Northwestern North America[1]

(Diptera : Psychodidae)

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Since an earlier report on four species of *Phlebotomus* from Washington (Fairchild and Harwood, 1961) attempts have been made to determine their life cycle by rearing and to obtain further information on northern limits of distribution. Adults were trapped from burrows of the yellow-bellied marmot, *Marmota flaviventris avara* Bangs, by the method previously reported. The purpose of marmot burrow habitation has not been determined, though it is suspected the immature stages develop there and adults use such sites for resting. Evidence from laboratory rearing makes it doubtful that mammals serve as the source of an adult blood meal.

Additional distribution records, though by no means exhaustive, indicate the northern limits include southern Alberta and British Columbia. Single collections received from cooperators contained *Phlebotomus oppidanus* Dampf from the vicinity of Kamloops, British Columbia; *Phlebotomus vexator occidentis* Fairchild and Hertig and *Phlebotomus aquilonius* Fairchild and Harwood from the vicinity of Police Creek in southern Alberta. A number of collections of these three species have been made from marmot burrows along the Snake River in Whitman County, Washington. Six days of trapping burrows of *Marmota monax* in mid-August of 1963 in the vicinity of Edmonton (54° N) and Peace River, Alberta (55.5° N) failed to yield *Phlebotomus*.

Chambers with moist plaster of Paris substrates were constructed for rearing experiments. General procedures resembled those described by Hertig and Johnson (1961). In place of porous bean pots, a plaster of Paris base was formed at the bottom and sides of 1-pint fiber ice-cream

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cartons, with a tongue of plaster of Paris extending below a hole in the bottom of the container. Each rearing chamber was placed on a jar filled with distilled water, and cheesecloth wick connecting between the plaster of Paris tongue and the water kept the rearing chamber substrate moist continuously. In a humid rearing room these chambers maintained adequate moisture for at least 2 weeks without replenishment of the water reservoir.

Oviposition was obtained by isolating gravid or engorged females in glass tubes plugged at the lower end with moist plaster of Paris. A moist strip of filter paper also served as a resting surface and oviposition site. The upper end of the tube was stoppered with absorbent cotton moistened with 10% sucrose solution, thus providing females with a carbohydrate source. Eggs were transferred to rearing chambers by washing them loose with distilled water and sucking them up with a medicine dropper, or if on filter paper a small part of the strip containing eggs was placed directly in a rearing chamber. All rearing, with exceptions noted hereafter, took place at 22° C in dim constant light.

A variety of larval foodstuffs was tried. The basal ingredient of all diets consisted of oven-dried (100° C) guinea pig feces. To this various groups had soil, brewer's yeast, soy flour, pulverized adult mosquitoes, and B vitamin mixtures added. Larvae were observed to feed on all of these foodstuffs, but insect material and some of the abundant molds seemed most acceptable. On several occasions larvae were seen feeding exclusively on a tan-colored *Aspergillus* mold growing up the plaster sides of the container.

Observations on life cycle are based on 25 females which oviposited in the laboratory after taking a blood meal, or as a consequence of being gravid at capture. From 19 instances where larvae were obtained (18 *P. vexator occidentis*, 1 *P. oppidanus*) a fairly complete analysis of post-embryonic development is possible. Figures related here are for *P. vexator occidentis* though the single group of *P. oppidanus* larvae were similar in growth characteristics.

Adults were offered a variety of vertebrates but fed exclusively on reptiles. Common garter snakes, bull snakes, and two other species of nonpoisonous snakes, and a small lizard were all acceptable. Larger snakes, near 2 feet in length, seemed most readily fed upon. No feeding occurred upon proffered frogs, young or adult white mice, or humans.

Egg development following a blood meal was quite variable. Of nine cases where the timing was relatively exact the preoviposition period varied from 8 to 18 days, a period of 12 days seeming to be most frequent. It is doubtful that the full ovipositional potential was realized

under laboratory conditions where only a single blood feeding took place since the females usually died during the act of egg laying while often still containing fully developed eggs. Numbers of eggs actually laid by *P. vexator occidentis* ranged from 7–72 with an average of 34.2. Maximum potential for a single oviposition, as indicated by combining eggs laid with full-sized ones remaining in the dead female, was 86. Time from oviposition to larval hatching was 13–14 days.

In most instances larval development was halted by diapause in the last instar. Such diapause is characterized by very low larval activity and infrequent feeding. There is evidence that adult emergence early in the season is most likely to yield nondiapause larvae. One *P. oppidanus* captured on 22 June produced five larvae, three of which (60%) underwent uninterrupted development. A *P. vexator occidentis* captured on 29 June produced 21 larvae, 8 of which (38%) developed without diapause. In only two instances (*P. vexator occidentis*) did nondiapause development occur in the progeny of the females collected after June. One individual captured on 30 July produced 21 larvae from which 2 pupae (9.5%) were obtained; the other captured 10 September produced 14 larvae, one of which (7%) pupated. The nondiapause larval period of progeny from June-captured females took 33–36 days whereas that of the July-captured female took 58 and 212 days and that of the September female took 208 days. Clearly there is a single annual generation in Washington (47° latitude), and nondiapause early season progeny must seldom produce offspring which can reach the last larval instar diapause before low temperatures occur.

The diapause observed was not successfully broken though a number of environmental factors were varied. The methods used are briefly mentioned as a guideline for further investigation. In one instance diapause larvae were held at 10° C and 8-hour daily photoperiod for 30 days, being then changed to 22° C and 16-hour photoperiod. Another group was held in the dark at 2° C for 7 days and then returned to standard rearing conditions. Three groups were fed on a diet fortified with B vitamins by soaking dried mosquitoes in the vitamin mixture listed by Fraenkel (1952) for the diet of stored grain insects.

Pupal duration ranged from 12 to 20 days, 17 days appearing to be most frequent. In the few instances where adults of both sexes were reared through it was not possible to obtain mating and feeding on snakes. Mating was observed on three occasions when field-captured adults were confined with a snake.

Total number of *Phlebotomus* worked with was rather small, making observations somewhat imprecise though certain conclusions can be

reached. The present evidence makes it unlikely that the four species of sandflies encountered are of medical importance. Thus far the two commonest species have fed only on reptiles, appear to be relatively short lived as adults, usually have a single annual generation, and lay eggs once, indicating they do not feed repetitively on vertebrates.

Observations related here for the life cycle of *P. vexator occidentis* and *P. oppidanus* agree rather well with those of Chaniotis and Anderson (1964) for the former species in California. Diapause seems to be the rule in Washington, no doubt because of the higher northern latitude and attendant shorter period of favorable developmental temperatures. For northwestern North America it appears that the northern fringe of distribution of *Phlebotomus* extends a short distance into Canada just beyond 50° N latitude. Further extensions northward may be found where locally suitable climatic conditions pertain.

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