BITING MIDGES (DIPTERA:CERATOPOGONIDAE) REARED FROM ROTTING CACTUS IN AUSTRALIA

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This paper reports the occurrence of *Culicoides loughnani* Edwards 1922 in Australia and discusses the possibility of its introduction from the Neotropical Region.

Identity of the Australian specimens has been determined with the aid of published descriptions, principally that of Wirth and Hubert (1960), and by comparison with *C. loughnani* from Texas, U.S.A. The presentation of quantitative data for the Australian series follows that used by Wirth and Hubert (1960) and Wirth and Blanton (1959), thus facilitating comparison with data published by those authors for *C. loughnani* and the closely related *Culicoides jamaicensis* Edwards 1922, respectively. Measurements and descriptions are from specimens of Australian origin cleared in creosote and mounted in Canada balsam. Wing measurements were taken at 50X magnification and antennae, palps and spermathecae at 320X; all measurements were taken by means of an ocular micrometer and are expressed in mm. One unit of proportion equals 0.0036 mm. Segments of palps and antennae were measured individually and any which showed signs of shrinkage or were not horizontally oriented in the mountant were excluded. The distinctive wings and spermathecae are figured along with the antennae, which have not been illustrated previously.

The bulk of the Australian series examined is deposited in the Australian National Insect Collection (A.N.I.C.), Canberra, with representative specimens distributed to the U.S. National Museum, Washington; British Museum (Natural History), London; Bernice P. Bishop Museum, Honolulu; and the School of Public Health and Tropical Medicine, University of Sydney.

DESCRIPTIVE

Culicoides loughnani Edwards

Female. Wing length 1.22 (1.09–1.30, n=26).

Head: Antennae (Fig. 1-B) with lengths of flagella segments in proportion of 13:9:9:10:10:10:10:11:17:18:19:20:26; antennal ratio 1.20 (1.12–1.30, n=39); sensory tufts on segments III–XV as figured. Palpal segments with lengths in proportion of 8:9:33:9:8; third segment 2.6 (2.3–2.9, n=43) times as long as greatest breadth. Mandible with 16 (14–17, n=32) fine teeth.

Wing: Extensive pale markings distinctive for the species (Fig. 1-A). Costa extending to 0.56 (0.54–0.59, n=25) of distance to wing tip.

Thorax: Dark; scutal pattern distinct. Dark brown to black median vitta and pair of dark brown sublaterals. Ground colour ashen with ochrous tinge increasing posteriorly.

Abdomen: Pale with small and inconspicuous sclerotized ventral plates on the segments. Two fully developed spermathecae elongate and unequal with large openings to unsclerotized ducts; a third rudimentary organ present (Fig. 1-D and E). The fully developed spermathecae vary considerably in proportions and shape in different specimens, mean measurements being 0.070 by 0.031 and 0.061 by 0.022 (n=20 pairs).

Male. Wing length 1.00 (0.95–1.05, n=16).

Head: Terminal three segments of the antennae (Fig. 1-C), each bearing sensory tufts.

Genitalia: Agreeing in detail with the description by Wirth and Hubert (1960) except for the presence of a caudomedian

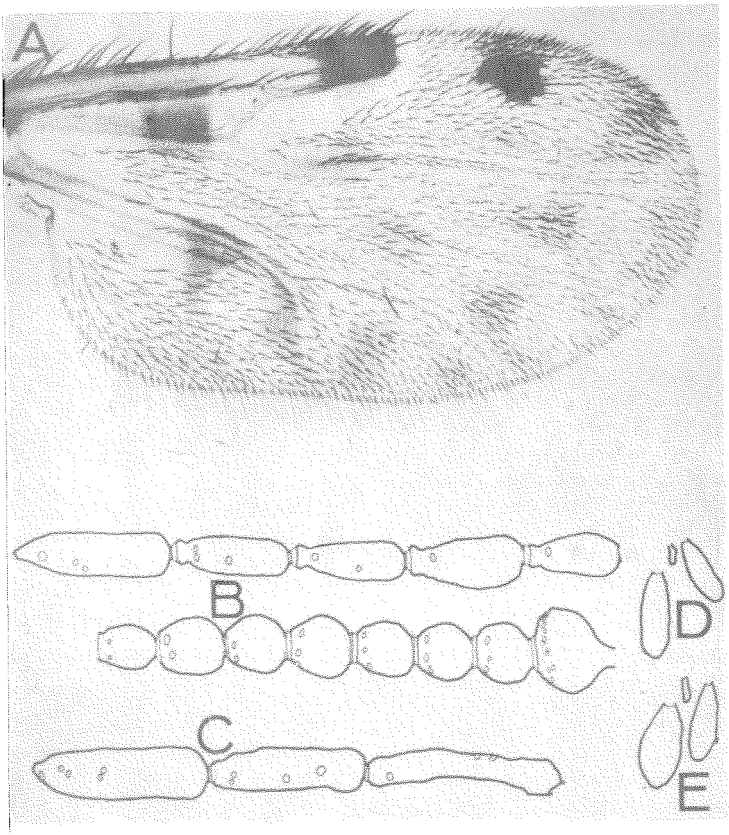

FIG. 1.—*C. loughnani* Edw. reared from *Opuntia inermis* at Redbank Plains, Queensland, Australia.
A. Wing of ♀ (specimen number 67–255–18, A.N.I.C.).
B. ♀ antenna (67–255–1); segments III–XV showing arrangements of setulose sensillae.
C. ♂ antennal segments XIII–XV.
D. and E. Spermathecae from two females (67–255–21 and 67–255–15) reared from the same rot pocket.

excavation in the ninth sternum of all Australian specimens examined.

SPECIMENS EXAMINED. U.S.A.—1 ♂, 1 ♀, Aransas Refuge, Aransas County, Texas, 10.vi.1956, R. H. Jones, light trap; 1 ♂ Aransas Refuge, 22.vi.1956, Wirth and Jones, light trap.

AUSTRALIA.—1 ♀, Noondoo, Qld., 16.xii.1963, A. L. Dyce, light trap; 1 ♂, 5 ♀ ♀, Mt. Crosby, Qld. 4.xii.1965, H. A. Standfast, light trap; 1 ♀, Mt. Crosby, 4.xii.1965, A.L.D., light trap; 5 ♀ ♀, Dinmore, Qld., 5.xii.1965, A.L.D. and M. D. Murray, light trap; 19 ♂ ♂, 35 ♀ ♀, Redbank Plains, Qld., 12.xii.1967, A.L.D., reared from *Opuntia inermis;* 2 ♀ ♀, Redbank Plains, 12.xi.1967, A.L.D., light trap; 20 ♂ ♂, 5 ♀ ♀, Redbank Plains, 27.iii.1968, A.L.D., reared from *O. inermis.*

COMMENTS. The wing length and antennal and palpal ratios of females of the Australian series do not agree with data presented for *C. loughnani* in Table 1 of

Wirth and Hubert (1960). The mean antennal ratio is nearer to that shown for the closely related *C. jamaicensis*. Males of the series also resemble *C. jamaicensis* in the possession of a caudomedian excavation of the ninth sternum (Wirth and Blanton 1959) but the aedeagus is of proportions described for *C. loughnani*. It is possible that examination of larger American series of both these species than were available to the above authors may resolve the differences. For the present, however, the extent of pale wing markings and elongate sac-like spermathecae indicate the Australian specimens to be *Culicoides loughnani* Edwards.

BIOLOGY. The 15 *C. loughnani* specimens taken as adults in Australia were all from light trap collections. The presence of only two females in a total catch of 863 *Culicoides* specimens at Redbank Plains on December 12, 1967 suggests that *C. loughnani* is not readily attracted to light. From the abundance of empty pupal cases in breeding places examined at the site earlier in the day, the population of adults was anticipated to be higher than the trap yield would indicate. The 14 adult females taken at light were examined and classified (*v.* Dyce 1969). Eleven were fully gravid, two were unfed and nulliparous and one was parous with undeveloped ovaries and an empty gut.

Several breeding foci with pupae and high densities of larvae of mixed stadia were located in rotting stems of *O. inermis* (prickly pear) plants at Redbank Plains, Queensland (Fig. 2). This particular stand of prickly pear was harbouring a moderate infestation of caterpillars of *Cactoblastis cactorum* (Berg.) believed to be responsible for initiating the rot. Immature stages of *C. loughnani* were found only in the dark brown, non-gelatinous fluid of even consistency characteristic of advanced necrosis in both aerial stems and below ground level in the base of the host plant, and were clearly visible to the naked eye. The amber coloured pupae lay at the surface and the cream coloured

FIG. 2.—A collection site of *C. loughnani* Edw. at Redbank Plains, Queensland, Australia. Host plants, *Opuntia inermis*, scattered through grass sward in an open stand of mixed *Eucalyptus* spp.

larvae contrasted strongly as they moved through the dark fluid. Found in association with *C. loughnani* were a *Dasyhelea* sp. (nr. *ryckmani* Wirth and Hubert 1960), other dipterous larvae including drosophilids and syrphids, adults and larvae of beetles, and at least two species of mites on the drying marginal surfaces. Colonies of small black ants were established in the dried tissues.

A sample of larvae in approximately 10 ml. of rot fluid was held at temperatures of 18–23° C. in the laboratory. After ten days, the fluid supported a loose growth of fungus on the aerial hyphae of which a large number of nematodes was observed waving to and fro, in a manner similar to that described by Bovien (1937, p. 23) for "dauer" larvae. In spite of the fungus and nematodes the biting midge larvae thrived. Pale, newly formed, pupae were taken off twice daily and washed in tap water to remove adhering rot material. They were reared individually on moistened tissue wads in stoppered glass vials according to the method of Dyce and Murray (1966). For all specimens that pupated and emerged in captivity the mean pupal term was 48 ± 12 hrs ($n=46$). Adults accepted sugar solution but attempts to induce females to take a blood meal from the human forearm were unsuccessful. Females were not inseminated, nor did follicles develop beyond Mer's Stage I (Linley, 1966).

THE HOST PLANTS IN AUSTRALIA

The known history of prickly pears in Australia is documented in the extensive literature on the biological control of pest species. Dodd (1927) stated "at least 24 species of prickly pear are found growing wild in Australia; the origin of their introduction is unknown in most cases but it is certain that the first prickly pear was imported from Brazil by Governor Phillip and the first colonists in 1788, the species being, probably, *O. monocantha* . . ." It was reported by Alexander (1919) that "It was not until 1870 that they (the 'prickly pears') appear first to have got out of control." On June 1, 1920 the Commonwealth Prickly Pear Board was established to carry out investigations into the possibilities of biological control of the pest. A wide variety of insects and other organisms were subsequently introduced from America; mainly from Florida, Texas and California. Various methods of introduction were used, the major one being the shipment of infested plants established and growing in large gauze covered crates. The procedure has been concisely recounted by Dodd (1927): "Shipments of clean stocks of insects are made in specially constructed cases, which are packed with sufficient prickly pear growing in damp sphagnum moss to ensure a food supply throughout the journey. Since the commencement of investigations (i.e. seven years) 30 separate shipments comprising 300 cases, and many thousands of insects have been made. The cases are forwarded by mail train to San Francisco where they are placed on the boat deck of the steamer for conveyance to Sydney. From Sydney they travel by mail train to Brisbane." The *Cactoblastis* moth was brought in from the Argentine in March 1925 (Rivett, 1927).

Of particular interest here is an account of the transport of rot organisms by Alexander (1925): "From the United States diseased joints collected in the field were sent to Australia by post either in paper packages or in mailing cases provided with plenty of ventilation. Both methods proved very unsatisfactory. In all cases the joints arrived in rotting condition, and in several cases the liquified joint had leaked out of the container, in transit, leaving only a few vascular bundles behind."

DISCUSSION

Breeding of *C. loughnani* in rotting cactus in America was first reported by Jones (1962); the possibility had been strongly indicated earlier by the work of Wirth and

FIG. 2.—B. Rot pocket in *Opuntia inermis* cut to show a typical breeding place of *C. loughnani* Edw. A trickle of the dark fluid contents is visible on the outside of the stem.

Hubert (1960). At Redbank Plains immature *C. loughnani* were found in persistent pockets of rot fluid in the stems of prickly pear (Fig. 2B). All breeding places located were in plants of *Opuntia inermis* that showed evidence of extensive attack by *Cactoblastis cactorum*. Other species of prickly pear growing at Redbank Plains were not infested by *C. cactorum,* nor were rot pockets located in them. Adults of *C. loughnani* were taken at three other sites in southern Queensland and in each instance *O. inermis* plants infested by *C. cactorum* were present nearby.

This apparent close association between *C. loughnani* and plants of *O. inermis* infested with *C. cactorum* is probably an exotic phenomenon peculiar to Australia. It is not expected to prevail in the arid parts of the American tropics where both indigenous cacti and organisms which attack them are more diverse and, according to Ryckman (1960), breeding places suitable for a number of other cactiphilic Ceratopogonidae develop in a wide range of host plant species.

A large proportion of the insect-infested and diseased plant material imported into Australia with the view to control of prickly pear came from within the known distribution range of *C. loughnani* in America. Prior to those introductions, prickly pear in Australia was "almost wholly exempt from insect attack" (Dodd, 1927) and there is no mention in the literature of soft rots occurring. It is therefore suggested that *C. loughnani* was transported across the Pacific Ocean with the biological control materials during the 1920–1930 prickly pear control campaign. The species was probably transported as larvae inside rotting stems and escaped as adults on or after arrival. Protracted larval life, sufficiently long to cover the

sea voyage, is not uncommon amongst *Culicoides* species. Unpublished observations in this laboratory have shown that tree-hole breeding species in particular may survive as active late stage larvae for several months. It is from species such as these that *C. loughnani* is believed to have evolved (Wirth and Hubert, 1960). The series of *Dasyhelea* sp. found breeding in association with *C. loughnani* at Redbank Plains suggests that other species of Neotropical biting midges may also have been introduced along with *C. loughnani*.

SUMMARY

The occurrence of *Culicoides loughnani* Edw. breeding in rotting cactus in Australia is reported and evidence of its introduction there from the Neotropical region is presented and discussed.

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