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Australian Endemic *Drosophila* II. A New *Hibiscus*-breeding Species with its Description

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Abstract

D. hibisci is a new species of the typically Australian subgenus *Scaptodrosophila* breeding in the flowers of two endemic *Hibiscus* species in south-eastern Queensland. The biology of the species based on field and laboratory observations is discussed and a description provided. The prognosis for future laboratory culture of the species is encouraging.

Introduction

The genus *Drosophila* is diverse and cosmopolitan. Known breeding sites include fallen fruits and flowers; slime fluxes of trees; decaying bark, leaves, stems and roots; fleshy fungi; living flowers; leaves (as leaf miners); and even, in the case of two highly specialized species, the branchial chambers of terrestrial crabs (Carson 1971). Here we report on a new Australian species, *D. hibisci*, exploiting living *Hibiscus* flowers as a resource. *D. hibisci* belongs to the typically Australian subgenus *Scaptodrosophila* (Bock and Parsons 1975; Parsons and Bock 1977). Previous reports of flower-breeding *Drosophila* species include members of the small subgenus *Phloridosa* and the *flavopilosa* species-group of the subgenus *Drosophila* (Okada 1975) as well as several *Scaptodrosophila* species.

Flower-breeding *Drosophila* species, if not well known, have at least been recorded from several regions in the past, generally in the large attached tubular flowers of appropriate plant species. Lachaise (1974) provided a summary of the occurrence of plants with flowers inhabited by drosophilids (adults, larvae, or both) together with flower-inhabiting drosophilids recorded in the Ethiopian biogeographic zone. Five plant genera in four families were listed from the Nearctic zone, 16 genera in 11 families from the Neotropical zone, and 18 genera in 13 families from the Ethiopian zone. Both adult and larval drosophilids were recorded in one *Hibiscus* sp. from the Nearctic zone, while adults only were recorded in three *Hibiscus* spp. from the Ethiopian zone, the latter flies comprising three species of *Drosophila* (subgenus *Scaptodrosophila*) and one of *Mycodrosophila*.

The most thoroughly studied flower-breeding species to date, *D. flavopilosa*, occurs in South America and breeds in the flowers of the solanaceous shrub *Cestrum parqui* (Brncic 1966); in common with many flower-breeding species it cannot be cultured in the laboratory, presumably because of a dependence upon a resource highly specific to the flowers of this shrub.

Reports of flower-inhabiting *Scaptodrosophila* species are few but include the above-mentioned West African species, *D. aterrima* Duda, *D. ebena* Graber and *D. pseudoebena* Graber. Adults of *D. aterrima* have been recorded in the flowers of species of *Crinum*, *Canna*, *Ipomoea*, *Cucurbita*, *Melo*, *Hibiscus* and *Datura*, while both adults and larvae have been found in *Ipomoea digitata* (Lachaise 1974).

Graber (in Okada 1975) found *aterrima* larvae breeding in fallen flowers, including those of melon, at Kibati, Congo; he also found the adults of all three species to have intestines full of pollen. It therefore appears that the adults are pollen feeders, while the larvae exploit the fleshy tissues at the base of the flowers. To the north of Australia, *D.* (*Scaptodrosophila*) *scaptomyzoidea* has been found in the flowers of *Marvaviscus* in the campus of the University of Singapore, and specimens have been collected in the Botanical Garden, Bogor, Java (Okada 1975). The distribution of *D. scaptomyzoidea* was recorded by Bock (1976) as Micronesia and New Guinea, with two Queensland specimens, one near Gympie and the other at Bramston Beach; Bock and Parsons (unpublished) have recently collected a third specimen, by sweeping, near Mossman Gorge. The lack of records of possible flower-breeding species in the southern part of Australia (Parsons and Bock 1977) is not unreasonable, since the forests do not possess plant species with large attached tubular flowers, although it should be noted that on days of minimal high temperature–desiccation stress adults of the southern species, especially *D. inornata*, may be found on small flowers, perhaps feeding on nectar (Parsons and Bock 1977). By contrast, *D. hibisci* is known to exploit *Hibiscus heterophyllus* and *H. splendens*, both of which have appropriate flowers. Native *Hibiscus* species occur mainly in northern Australia (Wilson 1973).

Collection Methods and Site Ecologies

Adults of *D. hibisci* were readily aspirated from the petals and corolla tube of *H. heterophyllus*, which has white petals turning to red in the corolla tube (Fig. 2), and of *H. splendens*, which has pale pink petals turning to red in the corolla tube. Locations where *Hibiscus* flies were collected (to the immediate north of Brisbane) are shown in Fig. 1. The initial observations were in *H. splendens*, a species occupying rather arid habitats, usually well drained rocky outcrops often supporting little other vegetation; consequently the flowers are well exposed to the sun. *H. heterophyllus* occurs in similar open habitats, perhaps slightly less arid than *H. splendens*. The flies were not found in other flowers; for example, at the site near Montville (Fig. 1) *H. splendens* was growing in a hedge near to a well cultivated garden with many blooms, none of which contained *D. hibisci* except for the *H. splendens*, which contained about 20 flies per bloom. By contrast, all flowering *Hibiscus* plants examined had at least some flowers containing *D. hibisci*. Sweeping grasses around the *Hibiscus* plants yielded no flies; baitings with mushroom, honey and water, and fermented banana were unsuccessful.

Field Observations

Very few open flowers contained no flies. Numbers of flies were usually in the range 5–30; flies migrated short distances among flowers and plants when they were disturbed sufficiently to leave the flower. Under the climatic conditions prevailing, with temperatures in the 25–30°C range and relative humidities in the 75–83%

range, *H. splendens* flowers at Mt Tinbeerwah (Fig. 1) lasted only one day. Adult flies were not observed in the closed flowers on the day after flowering. On one particular day the sun emerged at 10.00 a.m. and the flowers were freshly opened by 10.30 a.m., when six flies were caught. A further 10 flies arrived in the next hour, followed by more, to reach the numbers given above. A flower from which the flies were removed in the afternoon was not recolonized by the evening; this implies that any resource utilization must begin soon after colonization on the day that the flowers are open, and that the colony in a flower is stable throughout the day.

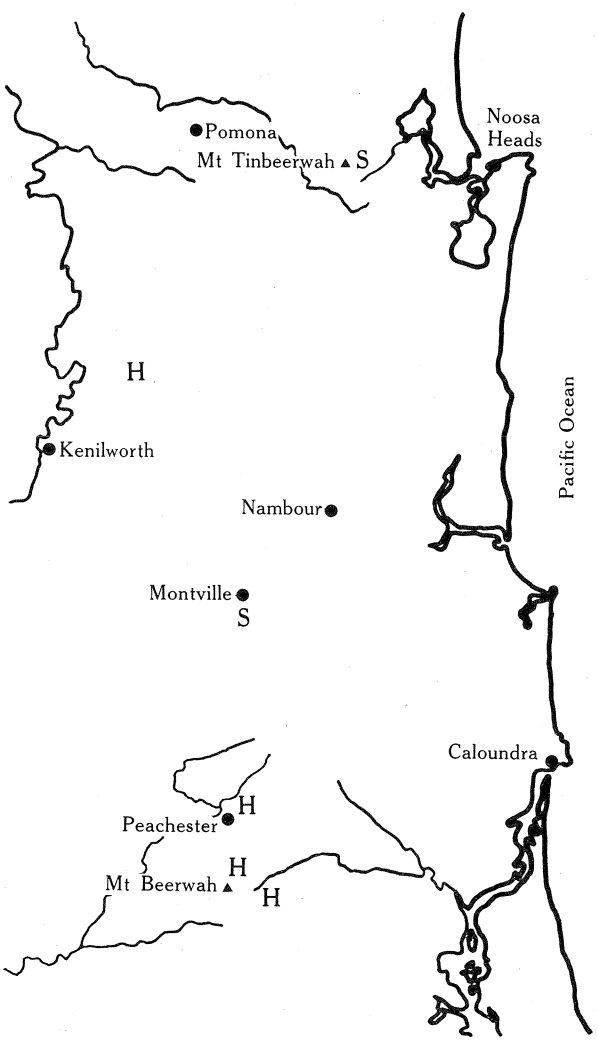


Fig. 1. Sites north of Brisbane where *D. hibisci* were collected from *H. heterophyllus* (H) and *H. spendens* (S).

Adult flies were seen feeding on pollen (Fig. 3) as do other flower-breeding species. The lack of success of conventional baits implies a certain specificity of resources utilized. The size of field-collected flies varied considerably, which suggests substantial variation in competition for larval food supply (cf. Kambysellis and Heed 1971).

Flies spend most of the time in the base of the corolla, around the filaments of the anthers. This is a humid microniche in a climate that is otherwise extreme for *Drosophila* (Parsons 1977), since *Drosophila* species collected by sweeping are rarely caught at temperatures over 25°C; however, the humidity in coastal regions of Queensland would, presumably, normally be high, at least in the hotter periods of the year, reducing the total desiccation–high temperature stress. Those flies not in the base of the corolla were usually in the shaded regions of the flower (Fig. 2), which shows that they avoid direct sunlight, as has also been noted in the southern Australian tree-fern sites (Parsons 1977).

Chasing-type interactions were observed from the basal region out to the petals; in a few cases this resulted in flies leaving the flower, but mostly the chased fly returned to the basal region. No copulating flies were observed, although some courtship-type interactions were evident (Fig. 3); in particular, partial wing extension by the following fly. It is possible that copulating pairs are concealed among the anthers of the flowers.

Laboratory Observations

H. heterophyllus flowers were collected into vials in the Peachester region; both *Drosophila* larvae and pupae were observed in the flowers. Three days after collection, four flowers were transferred to sand jars; 8 days later these yielded an average of 19·25 flies per flower; clearly the larvae are living and feeding in the flowers. Six similar flowers were put into tubes with standard *Drosophila* medium and yielded an average of 0·83 flies per flower. From this we suggest that the sand jar is more similar to the situation in the wild, i.e. some larvae pupate in the soil after the flowers have dropped to the ground.

In the laboratory a few adults emerged on artificial media (sugar vial plus yeast) 13 days after adult field-collected flies were placed on the media. Flies kept in a dense population (20 in a 10-cm vial) and exposed to a natural light–dark cycle oviposited on normal laboratory medium, but although many larvae pupated few flies eclosed.

Dissection of two freshly caught females disclosed five ovarioles per ovary in each, with a mature or nearly mature egg in each ovariole. On the other hand, dissection of nine laboratory 8-day-old hatched flies maintained as above on killed yeast medium showed no ovarian development. Dissection of wild-caught females 15 days after trapping demonstrated that their ovaries had regressed considerably.

Discussion

Where ovarioles were counted, the flies were found to be in the low range found by Kambysellis and Heed (1971) among the Hawaiian species; these are the species ovipositing and breeding on flowers, so having a low fecundity potential. Medium-fecundity species, breeding on decaying leaves, and those with a high fecundity potential, breeding on decaying stems, usually have more ovarioles; in the last

Fig. 2. Flower of *H. heterophyllus* showing *D. hibisci* on the petals. Note the aggregation of flies in a shaded region of the flower. Photograph taken in sunny weather; 31°C, RH 83%.

Fig. 3. Adult flies feeding on pollen with some courtship-type interactions on the petal of *H. heterophyllus*. Some anthers are at the top left.

category more than 100 ovarioles has been recorded. The limited food supply for the larvae is apparently the prime reason for the low fecundity potential of the flower-breeding species. Additionally, excessive oviposition on the same flower by several females is minimized, since the flowers are open for less than a day before they close permanently. It thus appears likely that the *Hibiscus* flowers provide courting and feeding sites for the adults, as well as the resources necessary for larval development; the *Hibiscus* flower is thus a primary breeding and feeding site for these flies. Nevertheless, the laboratory-rearing experiments indicate that both oviposition and occasional survival to imago can occur in the absence of *Hibiscus* flowers. However, the limited observations so far suggest that ovarian development is dependent, amongst other things, on *Hibiscus* flowers.

Considering other flower-breeding species, Pipkin *et al.* (1966) found that with one exception monophagous species of Central America did not eclose on laboratory media; indeed, for some species this was an inadequate stimulus for oviposition. Compared with the chances of most of these species, those of laboratory culture of *D. hibisci* must be regarded as highly favourable, especially with *Hibiscus* flowers and sand jars.

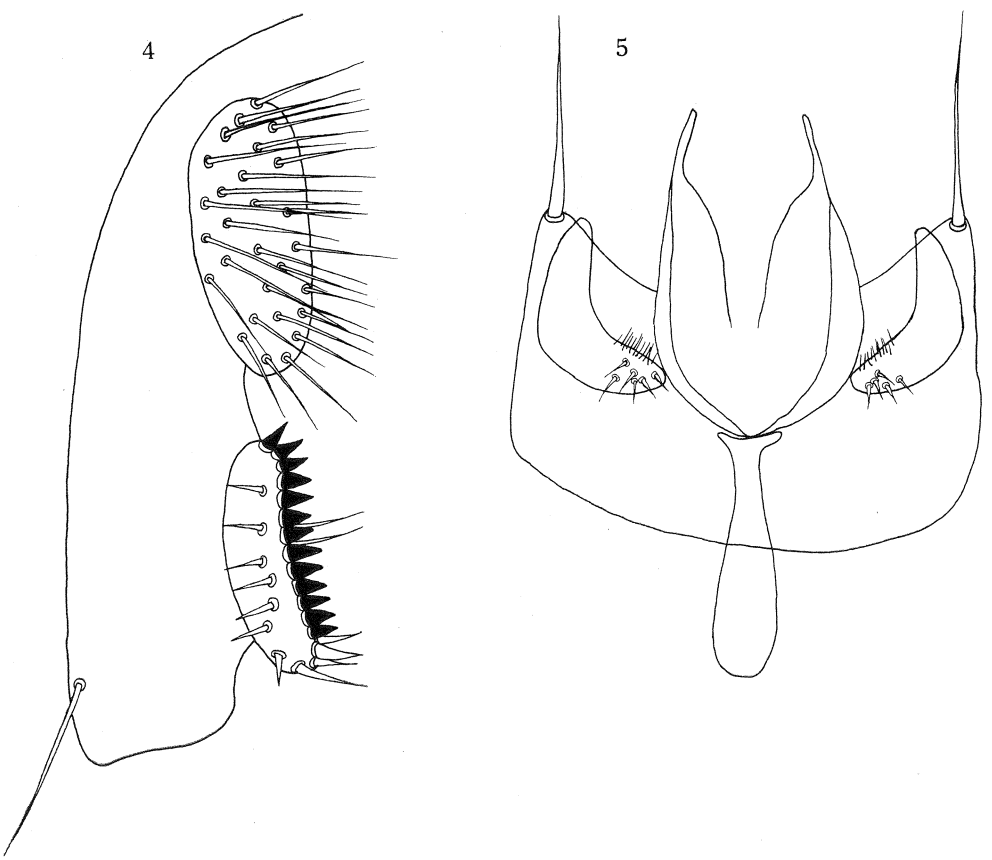
The utilization of *Hibiscus* flowers enables *D. hibisci* to spread to regions where temperature–humidity relations are extreme for *Drosophila* species (Parsons 1977), although a more extreme example is undoubtedly the desert-adapted cactus-breeding *Drosophila* of the Sonoran Desert, U.S.A. (Fellows and Heed 1972). The latter flies occur in rot pockets in cactus in a region of high temperatures and extreme aridity; they too have exploited a humid microniche in a habitat otherwise unsuitable for *Drosophila*. Evidence supporting this possibility comes from Prince and Parsons (1977), who found that in a temperature gradient at 100% RH *D. melanogaster* and *D. simulans* adults preferred temperatures above 30°C, while at 0% RH they preferred temperatures of <20°C. Furthermore, McKenzie (personal communication) has found *D. melanogaster* adults in the field in winery wastes at temperatures above 35°C under high humidity. Thus if there is no desiccation stress quite high temperatures may be tolerated, which is the likely situation for *D. hibisci*. Additionally, niches of this type do not appear to occur in inland Australia, which may be relevant in explaining the non-existence of an inland Australian *Drosophila* fauna.

The rot pockets of the cactus-breeding *D. nigrospiracula* are quite short-lived, maintaining populations for from 1 week to 3 months (Johnston and Heed 1976), which implies a continuous process of colonization of new rot pockets for the survival of the species. It is not, therefore, surprising that dispersal rates of *D. nigrospiracula* are the highest observed to date, especially from old, drying cacti. The *Hibiscus* niches are more stable than this, flowering occurring for some months each year, but the problem of what resources are utilized when *Hibiscus* is not flowering remains. Equally, it appears unlikely that plants or isolated groups of plants are recolonized each year, which would imply high dispersal rates, since groups of *Hibiscus* are often separated by considerable distances. *D. nigrospiracula* is so mobile that drift must play a minor role in its population structure; the population behaves as if it were panmictic. It remains to be seen what the situation is in *D. hibisci*, since if dispersal is very limited then populations should become differentiated to some extent into 'islands' (Wright 1951; Johnston and Heed 1976 for discussion). The answer will come most rapidly from studies of genetic variation as assessed by

electrophoretic analysis. Finally, as pointed out, the fecundity potential of *D. hibisci* is low for *Drosophila*, which implies rather small populations compared with most of the other species, which exploit resources with higher fecundity potentials. This is a situation which may well be more favourable to population differentiation within the species than that of *D. nigrospiracula*.

Species Description

D. hibisci is described below, following the method, terminology and abbreviations of Bock (1976).



Figs 4 and 5. *D. hibisci*, male genitalia: *4*, external (micropubescence not shown); *5*, internal.

***Drosophila* (*Scaptodrosophila*) *hibisci*,** sp. nov. Bock
(Figs 4, 5)

Types

Holotype ♂: ex flower of *Hibiscus heterophyllus*, Peachester, Queensland, 28.x.1976. Specimen deposited in ANIC.

Paratypes 9 ♀: same data as holotype. Specimens deposited in ANIC.

Distinguishing Features

Body entirely dark brown; rays of arista short; sternopleural bristles short; orbit with row of bristles additional to orbitals; reclinate orbitals displaced posteriorly.

Description

Body length. Holotype 2·3 mm; paratype range 1·8–2·4 mm.

Head. Arista with 3 rays above and 2 below plus terminal fork; all rays short and straight. Front 0·9× as wide as long, dark brown; periorbits and ocellar triangle silvery. 2nd and 3rd antennal segments, and carina, dark brown. Carina large and protuberant, flattened laterally and anteriorly. Cheek curved, not widened posteriorly, greatest width less than 0·1 greatest diameter of eye. Orbital bristles rather short, in ratio 3 : 2 : 3; reclinate orbitals displaced towards rear of head. Front with complete covering of small bristles; orbital margins with rows of slightly larger bristles anterior to, and in extended lines of, reclinate orbitals. Ocellar bristles short. Vertical bristles not greatly longer than postverticals.

Thorax. Uniformly dark brown. Acrostichal hairs in 8 regular rows in front of dorsocentral bristles, 6 almost regular rows between dorsocentrals. Prescutellar bristles as large as anterior dorsocentrals. Ratio anterior : posterior dorsocentrals 0·55. Anterior dorsocentrals very close to posterior dorsocentrals. Anterior scutellars divergent. Sterno-index 1·0. Sternopleural bristles unusually short. Legs concolorous with thorax; preapical bristles on 2nd and 3rd tibiae; apicals on 2nd tibiae only. Halteres pale.

Wings. Entirely clear, hyaline. *C*-index, 1·9; 4*V*-index, 2·1; 5*X*-index, 1·6; *M*-index, 0·6. 3rd costal section with heavy setation on basal 0·7. Length (holotype) 1·55 mm.

Abdomen. All tergites dark brown.

Male genitalia. Clasper (Fig. 4) large, with medial row of small teeth. Aedeagus (Fig. 5) greatly expanded apically; hypandrium with pair of large submedian spines.

Female genitalia. Egg guides strongly sclerotized, with large marginal teeth.

Distribution

Collected from flowers of *Hibiscus splendens* and *H. heterophyllus* in the localities shown in Fig. 1.

Since this paper was written, specimens have been found in flowers of *H. heterophyllus* north of Dungog, N.S.W., of various endemic *Hibiscus* species at University Farm, Camden, N.S.W., and of an endemic *Hibiscus* species near Mt Molloy and north of Cairns in north Queensland. A collection of mixed Drosophilidae received from the Division of Entomology, CSIRO, included 6 males and 11 females of *D. hibisci*, collected at Bukalara Plateau, 46 km south-south-west of Borroloola, N.T., on 23 April 1976, by D. H. Colless, on *Hibiscus* flowers.

Relationships

The species keys to *D. altera* in Bock (1976) but there are considerable differences between the two species in male genitalia, and *D. hibisci* does not appear to be very closely related to any other known species.

Acknowledgments

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