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tibiæ yellowish, rest of mid-and hind-legs blackish, pubescence black.

Wings clear, veins dark brown; stigma dark yellowish-brown; anterior branch of the third long vein with a short appendix.

Hab.—N.S.W.: Sydney (Dr. Cleland).

Both this and *T. milsoni* mihi, known from single specimens only, are closely related. *T. spadix* may be distinguished, *inter alia*, by its broader front, differently shaped, frontal callus, the thorax having five stripes; and the paler abdomen.

TABANUS VETUSTUS Walker.

List Dipt., i., p.179 (1848); Ricardo, Ann. Mag. Nat. Hist., (8), xvi., p.277 (1915); White, Pap. and Proc. Roy. Soc. Tas., 1915, p.15.

Hab.—Tasmania: Launceston (Simson, Coll. W. W. Froggatt).

This specimen has the third joint of the antennæ black, and, in addition, the abdomen is entirely clothed with thick, grey pubescence, except for two, small, median patches of yellowish pubescence on the first and second segments.

SOME NOTES ON THE BIONOMICS OF THE BUFFALO-FLY (*LYPEROSIA EXIGUA* de Meijere).

By Gerald F. Hill, F.E.S., Government Entomologist, Northern Territory of Australia.

(Plate liii.)

The Buffalo-fly, under which name it is best known to stock-owners in the Northern Territory, is well-known as an important pest, owing to the annoyance and suffering it causes to cattle and horses, and to the loss in condition so often observed in stock grazing upon fly-infested country.

The greater number of individuals of this species and the longer period of their seasonal occurrence make Lyperosia a more formidable pest than the larger and more voracious blood-sucking flies of the genera Tabanus and Silvius, both of which are well represented in this country.

During the early part of the wet season (November and December) certain species of Tabanus, notably *T. nigritarsis* Taylor, are responsible for perhaps more annoyance to horses than is caused by Buffalo-flies during these months. The actual loss of blood due to these larger Tabanids is, no doubt, considerable, and this, combined with the fact that horses, in particular, are kept in a constant state of motion from before sunrise until after nightfall, accounts in a large measure for the poverty of stock in certain localities at a season when pasturage is most abundant. But Tabanidæ do not attack abraded surfaces, sores, or the sites of recent bites, as Lyperosia does; hence, after a momentary flinch or a kick as the skin is pierced, little notice is generally taken of the fly by the host. The species which dash at their victim with most noise are more dreaded than the more sluggish species.

The wounds caused by even the largest Tabanidæ heal without showing signs of inflammation, but the blood, which frequently runs from the puncture after the withdrawal of the proboscis, attracts Stomoxys, Lyperosia, Musca, and other flies to the wound, which may thus develop into a characteristic "fly-sore." On the other hand, Lyperosias cluster in great numbers on a small area of skin, and, by repeated bites, produce what must be practically a constant state of irritation. This irritation causes the host to rub the part against some convenient object—a fence-post, stump, or branch—until a raw surface is exposed to further attacks by *Lyperosia exigua*, *Stomoxys calcitrans*, Musca, Pycnosoma, and other Diptera. The size and duration of the resulting sores are largely determined by the species and temperament of the host, its ability to find protection in mud, water, or undergrowth, by the prevalence of flies, and by the use or neglect (in the case of stabled or yarded domestic animals) of medicaments and repellant preparations. As may be supposed, horses suffer more in this respect than do cattle, and it is no uncommon occurrence to find, on the brisket, a raw surface of from 3-5 inches in diameter.

Old, poor-conditioned, and sickly stock (horses and cattle) are noticeably subject to annoyance. The colour of the hair makes no appreciable difference, although individuals may be seen which are practically unmolested; while others, in the same mob, are habitually infested. Goats are rarely molested, while dogs, pigs, sheep, and kangaroos appear to enjoy immunity from attack. Horses are generally attacked on the belly, brisket, underparts of the neck, flanks, about the eyes and withers, the characteristic lesions generally showing on the first three positions. Cattle are generally attacked on the belly, brisket, lower surface of the neck, the inner corners of the eyes, and on the flanks. The lesions are usually noticed on the neck, and in the corners of the eyes (Plate liii.), those in the latter position often presenting a very painful and inflamed appearance, due to the part being rubbed against the knees or scraped with the hind-hoofs.

Buffaloes, both domestic and those roaming wild in the country

to the East and South-East of Darwin, are habitually infested, and show the characteristic sores as found on domestic cattle and wild Brahmin cattle, but to a lesser degree, owing, no doubt, to the thickness of the skin, and the protection afforded by the submersion of the body and neck in mud or water for long periods throughout the day, and often to a protective coat of adhesive mud.

The habit of attacking man is exceptional in this species, although one is occasionally bitten while riding fly-infested horses. As has been stated above, wild buffaloes are habitually infested. While hunting these animals, it has been noticed that Lyperosias do not feed or rest upon a freshly skinned beast, but transfer themselves to the hunters' horses. In these circumstances, those engaged in skinning are not infrequently bitten, especially if the part is blood-stained or moist with sweat. Several species of Tabanidæ, not usually prone to bite man, will do so under similar circumstances.

Introduction into Australia and Local Distribution.

It is reasonable to suppose that the first importations of Lyperosia were made with some of the early shipments of stock (buffaloes, cattle, and ponies) from the East Indies, since 1824. That these flies can be transported by sea, a short distance at any rate, has been proved by the writer, who recently travelled from Port Darwin to the Daly River (90 miles by sea) in a small vessel, which carried two young bulls for the settlement situated about 60 miles up the river. A score or more flies were carried on these beasts for three days, and were dislodged only when their hosts were lowered into the river to swim ashore.

The distribution of the Buffalo-fly appears to coincide fairly well with the spread of the introduced buffaloes, which now roam wild over a large area of country roughly bounded by the Daly River on the south-west, the Roper River on the south, the Liverpool or perhaps the Goyder River on the west, and the littoral on the north. Although stray buffaloes have been found beyond these natural boundaries, the fly does not appear to have

made much headway south of the Roper River, or west of the Daly River. Melville Island, on which buffaloes have run since 1824, is said to be badly infested; while the adjacent Bathurst Island, which is stocked with goats only, is free.

Description of Early Stages, Life-History, and Habits.

The eggs, which are pale reddish-brown in colour, 1 mm. in length, curved on one side and flattened on the other, are laid singly on their sides on the wet surface of fresh dung, occasionally in crevices in dung or in fouled mud an inch or more away from it, and occasionally in fouled mud around buffalo-wallows. Oviposition takes from 2-4 minutes, during which time from 12-20 eggs are laid. The young larvæ descend into the dung, where they attain a length of 7·25 mm., and change in colour from nearly white to dirty-white. Under natural conditions, pupation sometimes takes place in the soil under the dung, but usually in the dung itself. In breeding-jars, pupation invariably took place in the latter situation, whether the dung rested on clean sand or on loamy soil. On two occasions, these flies have been observed depositing eggs on the hair of sweating horses, but it is most improbable that the resulting larvæ would reach maturity.

In the full-grown larvæ, the posterior stigmatic plates, which are situate on the hind margin of the anal segment, are large, blackish, rounded on the outer sides and nearly straight on the adjacent inner margins, with three, irregular, paler spots, and a central opening in each. On the ventral surface of the anal segment, there are several paired tubercles of varying size, surrounded by coarsely granulated skin. The puparium is of the usual Muscid type, 3 mm. in length by 1·30 mm. in width, barrel-shaped, and reddish-brown in colour.

Three reared under laboratory-conditions, in March, gave an average of 169 hours for the completion of the life-cycle (192, 195, 120 hours). The weather during the shortest period was warm and sultry, while a good deal of cool weather and rain were experienced during the longer periods. A later rearing (in June), when the weather was often chilly, took 208 hours to

complete the cycle. The periods occupied by the different stages were not accurately noted in any of the above rearings, but, from other observations under varying conditions, it was found to be as follows—egg-stage, 18-20 hours; larval stage, from hatching of egg to the formation of the puparium, 72-96 hours; pupal stage, 72-120 hours.

Courting takes place on the host, but the process of mating has not been observed, either upon the host or elsewhere. The position of the fly while resting or feeding upon the host is usually that with the body vertical and the head downward. During courtship, this position is maintained by one sex, the other occupying a vertical position with the head directed upwards. The wings of both are kept in constant vibration until the pair leave the host, presumably to couple.

During the heat of the day and at night, the majority of the flies rest upon the flanks and withers of horses, and about the horns of cattle.

Natural Enemies.—Few indigenous birds gather their food in dung; it is improbable, therefore, that dung-breeding flies and other insects are preyed upon in their earlier stages by these agents. The imagines of Lyperosia, like those of other flies, are preyed upon to some extent by Fantails (*Rhipidura bicolor*), which follow and rest upon the backs of stock.

Insect-predators play a more important part in the control of of this pest, but it is not believed to be considerable. The recently deposited eggs are gathered by certain species of ants for food, amongst which the following species may be mentioned —*Solenopsis germinata* F., var. *rufa* Snd., *Iridomyrmex detectus* Smith, and *Odontomachus ruficeps* Sm., var. *acutidens* Forel. A more important enemy is a small Hymenopteron (*Sericophorus reducens* Sm.) which captures the flies while feeding or at rest.

Methods of Control.—The flies are naturally bush-insects, breeding, for the most part, in the fresh droppings of cattle and buffaloes. Accumulations of stable-manure and litter do not attract them, nor do they breed up in numbers if fly-infested

horses are brought in from the bush, and kept in the stable or stable-yards. It has been observed frequently that, under such circumstances, the flies decrease and finally disappear. On the other hand, milking-pens and cow-yards in regular use do serve as breeding-places and sources of infestation. The frequent removal of manure from such places would do much to reduce the number of Lyperosia, as well as Stomoxys and non-blood-sucking Muscids in the vicinity, but to control their numbers on the immense and thinly-populated grazing-areas would be obviously impracticable.

Lyperosia exigua and disease.—None of the pathological conditions of stock in the Northern Territory are known to be transmitted by these flies, nor have the results of numerous microscopical examinations suggested their probable connection with the spread of disease.

EXPLANATION OF PLATE LIII.

Head of calf, showing early stage of lesion caused by *Lyperosia exigua*.