homes are essential. Food must be sufficient and physiologically balanced, including vitaminic content.

Lastly, recreation must be such as to maintain health—not undermine it.

The fulfilment of this programme requires the co-ordinated efforts of the Commonwealth, the State, the Councils, the medical, engineering, and architectural professions, and the cordial co-operation of every individual.

Mosquito-Larvivorous Fishes in Relation to Mosquito Reduction Work in Australia.

By L. E. COOLING, Assistant Entomologist, Australian Institute of Tropical Medicine, Townsville.

ALMOST a decade has passed since the value of some Australian fresh-water fishes was pointed out in connexion with mosquito-reduction work. Dr. J. S. C. Elkington, during the years 1912 and 1913, caused investigation to be made in association with the Brisbane mosquito work, and the results as relating to fishes were published in his report as Commissioner of Public Health for Queensland for the year ending 30th June, 1913.

Dismissing the effects of mere mechanical obstruction by siltage and excessive growth of vegetation, we might say that all the permanent fresh waters of Australia, *in a state of nature* (*i.e.*, untouched by man), harbor fish which greedily devour mosquito-larvæ. Too much, however, must not be expected from fish, for should the water abound in rank vegetation, and its edges be shallow and marshy, then it is well nigh impossible for fish to gain access to all parts of the water and so destroy the mosquito-larvæ. Generally speaking, however, the average type of marsh with fairly well-defined edges, does not breed mosquitoes by reason of the fishes with which it abounds. As soon as this is recognised a great many of our illusions about mosquito-breeding will be dispelled. It may be said that—at least in Southern Queensland—any fresh-water creek, or permanent or semi-permanent water-course can rarely, if ever, under natural circumstances, be shown to contain mosquitoes (and certainly never *domestic* mosquitoes), and repeated examinations over sufficient lengths of time will always place this statement beyond doubt.

There is a story told of the Sophist who, by his most abstruse methods of logical reasoning, thought he had sufficiently proved to Diogenes that he could not walk; the latter simply refuted all the theory and speculation by getting up and walking around his tub. So it should be in scientific investigation. We should not be satisfied with merely incriminating such-and-such a waterhole or swamp as breeding all our mosquitoes. Let us get up and observe, and a thousand chances to one we will find fish instead of mosquitoes.

Perhaps one of the most widely distributed mosquito-larvivorous fish in the eastern portion of Australia is *Melanotænia nigrans* *(Richardson)—a species which pursues its bond with such unrelenting fury as would suggest, in manner, the case of the wolf ravishing the fold.

* *Melanotænia nigrans* Richardson, 1843 (syn. *Rhombotractus fitzroyensis* Castelnau 1879). I am indebted to H. A. Longman, Esq., Director Queensland Museum, for the verification of this synonymy. By the law of priority Richardson's *nigrans* becomes the valid name for this species.

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M. nigrans R. (*Crimson-spotted Sun-fish*), attains a maximum total length of about 62 mm., although much smaller specimens are to be encountered. Its body is strongly compressed laterally, and the anal fin is high and very long, being composed of one spine and 19 rays. The colour is silvery brown, and the fins are spotted pink; there is a bright crimson lateral line which is observed to run from the vicinity of the operculum to the caudal peduncle. The species will live well in captivity for years, provided, of course, that the water be well oxygenated by the growth of aquatic vegetation, and even the smallest capacity of a gallon or two will suffice to give it a happy home. *M. nigrans* is by far the best of our mosquito-larvivorous fishes.

Another species—*Priopis olivaceus* (Ogilby) (*"the Green Perchlet"*)—is also a keen lover of mosquito diet, and its adaptation to life in artificial receptacles also hardly knows a limit. In this species the caudal fin is deeply forked, the middle rays being about half the length of the lobes. The colour is greenish above, and yellowish-white below. As a rule this fish does not exceed the length of 38 mm.

Carassiops (*Austrogobio*) *galii* (Ogilby) (*the "Firetail"*) is a third species which certainly considers mosquito larvæ with the taste of an epicure. It is pale olive green, more or less clouded dorsally with purplish-brown; the fins are hyaline, the dorsal and anal with a broad coppery marginal band, and the irides are silvery. *C.* (*A.*) *galii* lives well in confinement, and its normal state appears to be hungering after mosquito larvæ.

A word might be devoted to observation of fish under natural and artificial conditions. While some very encouraging results may be obtained by experiments conducted with fish in aquaria, it would be more or less fallacious to regard these as conclusive evidence as to what the fish in question might do under natural circumstances. Therefore, field observation is liable to be the more truthful. A case in point is *Pseudomugil signifer* (Kner.) (*the "Blue Eye"*), a species occurring both in salt marshes and fresh waters. While in the fresh-water aquarium this species displays marked predatory habits on mosquito larvæ, its presence in any salt marsh is not always indicative of the absence of mosquito larvæ *Culex vigilax* (Sk.), *C. sitiens* (Wiede), and *Mucidus alternans* (Westw.). It is probable that *P. signifer* finds a greater variety of diet in marine forms such as the smaller Crustacea—which, being often larger than mosquito-larvæ, are able to satisfy the pangs of appetite more readily. In fact, *P. signifer* appears to be endowed with notions of "dignity" about stooping to salt marsh mosquito-larvæ, but it certainly does not hesitate to devour them under the starvation test.

There are two other species which deserve consideration, and they are mentioned here as serving to illustrate the conditions of pollution. They are very feeble destroyers of mosquito-larvæ, and appear to be exclusively, or almost exclusively, vegetarian in habits, except during their fraternal differences, when they manifest a strong propensity to devouring the fins even of the members of their own species. The fishes

in question are *Carassiops compressus* (Krefft, 1864) (*the "Carp-Gudgeon"*) and *Mogurnda* (Richardson) var. *adspersus* (Castelnau, 1878); (*the "Trout-Gudgeon"*). These two species might be considered as valuable indicators of pollution, and "purification"—the only importance that can be attached to them in field observation work on mosquitoes; but before we can justly appreciate this condition, a word might be said as regards the effect of human habitation on streams and other natural waters.

When streams become polluted, as by sewers discharging into them, the water is obviously de-oxidized, and often becomes offensive. Fish inevitably succumb to such drastic artificial interference, with the result that the putrefactive bacteria and cyanophyceæ, and, more to the point, a certain species of mosquito-larvæ (*Culex quinquefasciatus* (Say))* step in and freely develop, and multiply on the "fat of the land". Now, it is well to bear in mind that the mosquito-larva, being an aerial breathing form, does not rely on free oxygen in waters; it is not a branchiate organism, and must rise to the surface in order to obtain air every now and again. De-oxidation of waters, therefore, has no inimical effects on the larva of *C. quinquefasciatus* such as it would have on fish. In fact, pollution is an aid to this species in the battle for life, for the simple reason that it weeds out all natural enemies of mosquitoes, and provides an abundance of putrescible food.

Nothing confronts the sanitarian in Queensland more than the natural selection of *C. quinquefasciatus* by artificial means. With the non-domestic mosquitoes, competition becomes very severe, and those species like the Anophelines (and other sylvan mosquitoes), which for the most part live in clean natural waters, must occupy these with their natural enemies, such as fish, water-bugs ("back-swimmers" or Notonectidæ) and so forth. In other words, clean natural waters (undisturbed by man) in Australia contribute very little to the non-domestic species of mosquitoes, and certainly not at all to the essentially domestic species. It is only when the natural restraining influences (fish, notonectidæ, &c.) are placed under subjection by the hand of man—as by sewage pollution—that the equilibrium of life is upset, and the resultant of this evil is a natural selection of the essentially nocturnal domestic mosquito *C. quinquefasciatus*. In fact, in the eastern part of Australia, *C. quinquefasciatus* might be classed as an "index of pollution of streams" and an index as to the number of sewage-collections in the way of septic-tanks, cesspools, dirty gutters, &c., about the district.

To revert to our Carp and Trout-Gudgeons, it is a fact well known to all that water-courses and streams which have become heavily polluted by sewage discharge will, if they are long enough and large enough, naturally "purify" themselves by nitrification, oxidation, dilution, and biological means. At least, they become sufficiently "purified", as is indicated by the biological test, with fish.

* Until recent years this species have been referred to as *Culex fatigans*, but by the law of priority, and, according to the International Code on Zoological Nomenclature, the specific name *quinquefasciatus* of Say, which was given (*Jnl. Acad. Nat. Sci.* Phila. iii., 10,) in 1823, will have to replace Wiedemann's species *fatigans* by which name the "Brown House-Mosquito" of Australia has been previously designated, but which was not created until 1828—*i.e.* five years after Say's name.

The word "purified" is used relatively; and, even bacteriologically speaking, it will hold good in proportion to the length of the stream, and the dilution. At least, it is indisputable that where essentially parasitic bacteria come into contact with the essentially saprophytic and free-living forms, there is an inevitable struggle for existence, and the dominant forms, in this case our Saprobes, will ultimately reign "top dog." At a stage when there is still a very obvious amount of sulphuretted hydrogen and sulphates still in the water—as is indicated when the typical "sewage fungus" *Beggiatoa alba"* is commencing to give way to the Cyanophyceæ, we observe the presence of Carp and Trout-Gudgeons. In fact, these fishes are able to withstand a comparatively high concentration of sewage, and otherwise so tenacious of life are they that specimens of one of the species have been forwarded through packet post merely wrapped up in a moist rag, and, after undergoing a couple of days of the throes and sorrows of packet-post treatment, being put into water, they were "resuscitated", and appeared none the worse for the drastic transaction. There is, then, no wonder that these fish become so tolerant of municipal foibles in the way of sewage disposal. To make a slight digression, this is thrown out as a gentle hint to those analysts who pin themselves down to the fish biological test of sewer-effluents without taking into consideration the species of fish used.

To carry the natural purification of our streamlet further, we might say that it is only at that point where the typically green *Algæ* grow in luxurious abundance, that we get the re-establishment of our larvivorous fishes. Space forbids that we touch on the members of this large microcosm responsible for the natural purification of streamlets, but one thing is certain, that a sewage-polluted streamlet in an area is an unnatural circumstance, and when it occurs we inevitably get the domestic night-prowling mosquito, *Culex quinquefasciatus*.

When it is remembered that *C. quinquefasciatus* is a potential intermediary host for *Filaria bancrofti*, that it never occurs naturally as a bush mosquito, but as a follower of man, then we are in a position to comprehend the very far-reaching effects of such a filthy, antiquated method as sewage-discharge into small streams, and consequent sewage-pollution of natural waters. In other words (certain exceptions being made for the strictly household breeding places for *C. quinquefasciatus*) the reduction of filariasis in Queensland is a work intimately co-ordinated with ordinary municipal drainage, sewerage and sanitation; so that measures guarding against the stagnation of sewage in any form (whether in septic tanks, water-courses, &c.) must result in the suppression of perhaps 90 per cent. of the numbers of *C. quinquefasciatus*, and in turn have a beneficial influence on the filarial endemicity in a given locality. The nursery tale about the "cat beginning to eat the rat" and so forth depicts the case admirably, and filariasis in a given locality is more or less directly connected with the proper disposal of sewage. As Charles Darwin stated (*cf. The Origin of Species*) years ago that cats regulated field mice, which latter in turn regulated insects, which in turn pollinized certain kinds of clover, and that the presence of cats, therefore, influenced the growth of certain clover, Huxley humorously extended the argument to the influence of old maids on clover, since the former made pets

of cats, and so put a greater restraining influence on the field mice. Perhaps the old-time sanitarian who smelt drains, and looked wise—although attacking the situation from other view-points—sometimes unconsciously wrought a large amount of good.

To sum up, Man selects *C. quinquefasciatus* by weeding out its natural enemies, and its reduction (together with filariasis) is a work intimately bound up with general sanitation. By guarding against pollution of streamlets, fish multiplication is encouraged, and the propagation of *domestic* mosquitoes restricted.

Cremation as a Public Health Measure.

By J. M. CREED, M.L.C., Parliament House, Sydney.

FROM a sanitary stand-point, there can be no subject relating to public health more immediately important than the disposal of the dead.

All diseases, in my opinion, are dependent on one of two causes —germs, or nerve supply, or on both combined. The destruction of disease germs would eliminate the major portion of these dangers. The only certain means by which they can be destroyed is fire. No disinfectant, however carefully employed, can be equally effective. Only those organisms on the surface of a body can be affected, while those in the viscera, which generally contain more than any other part, will remain active to be spread on the destruction of the tissues. In earth burial a majority are preserved, whilst if cremation is the process made use of, not one can escape.

No doubt some disease germs are more persistently virulent than others, but, to secure safety, all should be treated alike. The most dangerous are possibly those of anthrax, which the researches of Pasteur showed may be buried many feet below the surface and yet be virulently active after many years, being brought to the grass by earth worms, when they often affect grazing cattle and sheep. Examples of this are not infrequently brought to general knowledge by reports in the newspapers of the unexpected deaths of numerous sheep and cattle when travelling. The deaths are so numerous and sudden that the cause is generally supposed by the drovers in charge to be the consumption of some poison plant, when in truth the real cause has been this virulent disease. An example of death of a human being is that of a lady who resided within a few hundred yards of the Necropolis, at Rookwood, and who was affected by what was called "a carbuncle" on the upper lip. She recollected having been bitten on the spot by a fly. Death ensued in about a week. The source of infection was probably the adjacent cemetery, although it may possibly have been a beast dying in the sale-yards at Flemington, some three miles away.

Plague is caused by disease germs normally affecting rats which infect fleas, and these latter deserting the dead rats convey the plague germs to human beings by biting.

The first case of plague in Australia was probably that of a man who kept a sail-loft in Sydney. He received from New Caledonia some sails from a vessel wrecked there. When unrolled, a number of dried dead rats were found and thrown about the loft. Germs from these, it is probable, infected healthy rodents infesting the building. The man in question was consequently infected, and died very quickly.

Before germs were discovered, outbreaks of disease were not so traceable as they now are with our increased knowledge. In the middle of the last century, the superfluous earth was removed from the churchyard at Minchinhampton, in Gloucestershire, and spread in the gardens of the town. Disease, which was fatal in many cases, quickly spread through the place. A similar example occurred in a village in Essex, and in this instance the disease was found to be scarlet fever, which broke out in an exceedingly virulent form after earth, which had been removed from over the graves of persons who had died of it many years before, had been scattered in the neighbourhood.

Tuberculosis was found by Doctors Lortet and Depugne, of Lyons, in France, to persist in the soil upon the graves of those who had died from it. They discovered also that worms living in the earth were infected.

The virulence of germs was shown very recently by the occurrence of Botulism in a picnic party at Loch Mare, in Scotland. From ten in number, eight died; the remaining two had not apparently partaken of the microbe-infected food.

Another instance of the persistence of germs in the earth will be remembered as that of the much lamented Commodore Goodenough, C.B.R.N., who in 1875 was, with some of his sailors, slightly wounded by the natives of the island of Santa Cruz, in the New Hebrides, by poisoned arrows. Wounds from these weapons were rendered fatal by the previous insertion of the arrows in the moist soil of a native cemetery infected with the germs of tetanus. These became attached to the arrow points, and those wounded by them, including the Commodore, died within a fortnight. Another example of the persistence of germs is given in the book relating to the late Sir Ernest Shackleton's first expedition to the Antarctic. Notwithstanding the hardships to which they were subjected from overwork, cold, insufficient food, &c., the members were in good health until a bale of clothing packed in London was opened. In a very short time, every man was attacked by what is known as "a cold." It is evident that, until brought to the southern ice-bound land there were no germs there, yet at once on their being liberated they became powerfully infective.

Cholera is probably the most rapidly fatal of all diseases, but its prevention by fitting precautions is comparatively easy. An instance is that of the British-India mail steamer *Dorunda,* which called at Batavia, where cholera was at one time prevalent, on her way to Brisbane. Four days after leaving Java the first death from cholera occurred, and seventeen fatalities followed before the ship reached Brisbane. On the advice of the late Sir Norman MacLaurin, the President of the Board of Health in New South Wales, all the water was pumped into the sea, and after disinfection, the tanks were refilled