

Economic Importance.

Biological Relations

Since, to the casual observer, the dragon flies appear to be neither directly harmful nor positively beneficial to man, very little time has been devoted to the study of their economic importance. ~~The~~ ^{the} nymphal state is of so much greater duration than the adult life, ^{that} it is in that period that we should expect to find the species most harmful or most beneficial as the case may be. The nymphs are, as has been noted before, carnivorous, and are most rapacious and undaunted hunters. Their food consists of any living thing which they are able to master, and almost all kinds of small aquatic creatures are devoured by them. Entomostraca, may-fly nymphs, back swimmers, water boatmen, small crustaceans, thin-shelled mollusks and coleopterous and dipterous larvae. In times of stress, when the desire for food becomes acute, ^{nymphs of same species} they do not hesitate at devouring one another, while the smaller species are habitually preyed upon by the larger. The very young fish are also not exempt from attack by these voracious demizens of the water. On one occasion an *Cruce* nymph was seen to seize and partially devour a fish larger than itself, and the attitude ~~upward~~ ^{upward} the nymphs of those interested in fish hatcheries, is one of deep disapprobation.

It is on record that in a piscicultural establishment in Hungary, 50,000 young fishes were put into a certain pond early in the spring. When the pond was examined in the fall, out of the 50,000, but fifty four fish remained alive, while of dragonfly nymphs, which appeared to the men in charge neither interesting for study, nor desirable for food, enormous numbers were present. The natural conclusion from such an occurrence would be that the dragonflies had overcome the fish in the struggle for existence. This case, however, appears to be an exceptional one, there is no doubt that the dragonfly nymphs are to a certain extent competitors of the trout for food, but as many species of nymphs are, in turn, devoured by the larger trout the balance is doubtless well preserved. The studies of the Senior Author in the Ceditondachas led to the conclusion that the nymphs of the genus Gomphus are wholly detrimental to the trout. They burrow shallowly under the silt of the bottom of the pond, in the proper foraging ground of the trout, and feed voraciously on the various insects belonging to the bottom fauna, which are especially relished by the trout, while they themselves, on account of their burrowing

Habits are rarely and perhaps never taken.

Salamanders are among the most dangerous enemies of the nymphs, they appear greatly to appreciate them as an article of diet, and no doubt destroy large numbers of them. Frogs are very dangerous to the adult dragon-flies, particularly to the ovipositing females, which they easily capture when they hover near the water or descend into it for the purpose of laying the eggs. *Merops formicivorus* lines its nest with their wings.

Some of the smaller dragon flies and particularly the small, ~~small~~ damselflies with their hesitating flight are captured by certain species of birds. Hellcott says of the *Picellulinae*, "The male fly back and forth, catching small insects for food, and searching for the females. While pursuing this apparent pleasure many of them sacrifice their lives to satisfy the greedy appetite of the King bird, who perches himself on the branch of a nearby tree where he can view the proceedings and swoop down whenever he is sure he can procure a dragonfly for his trouble." Williamson notes that "the smaller hawks, shrikes, cuckoos and flycatchers are the birds which most frequently feed upon *Idonata* but none of these species at any time makes them an exclusive article of diet."

Dragonflies, particularly newly emerged individuals are often found in the webs of spiders near the water from which the dragonflies came, but this appears

to be a comparatively universal occurrence and probably does not result in the destruction of an appreciable number of the insects.

The most direct service rendered to man by the dragonfly is in the destruction of many annoying little flies and gnats and particularly of the mosquitos, which are not only annoying but positively dangerous. The common name of "mosquito hawk" acknowledges our debt to the dragonfly in this particular. Dr. Robert W. LaSalle thought their efforts in destroying mosquitos so successful that he offered a prize for the best essay on the artificial rearing of dragon-flies as a means of destroying the mosquito. Several excellent essays were received and published in 1890, but the suggestion of cultivating the dragon flies did not prove practical. Kellogg has some interesting notes on the services of the dragon-fly, in Honolulu where the mosquitos are exceedingly numerous and troublesome. He says that in the daytime when many large dragon flies are on the wing, the mosquitos are very little in evidence, while directly it becomes dark, they appear in such swarms that life is scarcely worth living. His conclusion is that "in Samoa, ~~and as in~~ Hawaii, where the dragon flies are conspicuous by their abundance and variety they do much to keep in check the quickly breeding mosquitos.

While the natural habitat of nymphal dragon-flies is water, they appear to be able to live outside of the water for considerable periods without inconvenience other than that involved in a prolonged fast. The Rev. Arthur East published in "The Entomologist" for August-1900 - some observations on the subject, In his experiments two specimens were kept out of water for a month and when returned to the water, they appeared to be quite normal, except that they were, perhaps, abnormally hungry. This bears out the observation which has frequently been made that there is no perceptible lessening of the number of dragonflies after a very dry season when many of their favorite breeding places have dried up. W. J. Lucas in commenting on the season of 1896 says "What, however, constitutes the most striking feature of the season was the long summer drought and it will be interesting to note during the next three years its effect, especially on those species which had appeared early in the year, before the drying up of the ponds and streams. Information is unfortunately scanty with regard to such periods of drought, but what little there is seems to point to the fact that they have but slight harmful effect on Odonate existence. The eggs probably remain imbedded in the mud, where sufficient moisture remains to keep alive the little specks of proto-plasma, and it is not too much to

suppose that the nymphs may maintain their existence under the same conditions." Some entomologists have suggested that the great migrations of dragon flies, which have been recorded from nearly all parts of the world, may be caused by the drying up of the ponds in which the insects are accustomed to place their eggs.

Parasites - Cultivation of Peset's eggs -

Like many other creatures which are vigorous and active enough to withstand attacks of enemies of their own size, the dragon flies are infested by various parasites which destroy them when the more powerful enemies fail. These parasites attack the adult dragon flies, the nymphs and the eggs, and undoubtedly do most damage to the eggs.

In the Larnborne prize essay on "The Dipterous Enemies of Man" Mrs. C. B. Keeler records that "In the egg state we have found a small red mite, an Arachnid, which swims rapidly over the water in search of an Odonat egg, upon which it either deposits an egg or excavates it for immediate nourishment. A minute Dipteran, genus unknown, was also seen to oviposit on the egg of *Diflex*."

The micro. Hymanoptera are also parasitic on the eggs of various species of dragon-flies.

The abdominal cavity of the nymphs appears to be the home of several parasitic forms, from various

species of Libellula, Gordius has been reported as well as several species of sporozoans. On the under surface of the thorax or the abdomen of the adults, the small red mites, Chearini, are frequently found. - Parasites of fish-eggs - Aquatic insects N. Y. 1903 pg. 230

Uses of Dragon-flies -

The nymphal dragon-flies are excellent subjects for laboratory work, they are hardy creatures, easily adapting themselves to a changed environment, and living quite contentedly even in small quantities of not very well aerated water. They are able to undergo prolonged fasts, so that the omission of a meal does not result in high mortality. If one wishes to observe the habits of carnivorous insects, the dragon-fly nymph is a most conspicuous illustration. He will eat almost any live creature that is offered to him, immediately, without any exhibition of stage fright, even tho he is subjected to close scrutiny. The labium, whose operation has been discussed in detail elsewhere, is peculiar to the dragonfly and merits a careful examination.

Among the little dragonflies the curious respiratory apparatus is interesting and instructive; in this connection may be observed the ability of the nymph to propel itself forward for considerable distances with great swiftness, by violently expelling the water from the

abdominal cavity. The transformation of a dragonfly is seldom observed in the laboratory, as the insects prefer the hours of darkness for their great change. If, however, one does start to transform in the daytime, the spectacle is a marvelous and interesting one.