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Miscellanea.

Golubac Fly (*Simulium columbaczense*) in Yugoslav Danubian region.

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(Received: January 15th, 1952.)

The breeding places of the Golubac flies were first discovered by *Baranov* in 1934/36 and they were found, not as had been hitherto believed, in small brooks around Golubac town, but in the waters of the Danube itself. *Baranov* saw the *Simulium* larvae for the first time in 1934 on an anchorage line of a river mill near the village of Kladusnica (close to Kladovo). He believed the larvae to be those of "*Simulium tredecimatum Edwards*". However, when during the year 1935 these larvae, bred in an aquarium, developed into pupae and adult insects, he realized that they were not the supposed species of *S. tredecimatum Edwards*, since these pupae had 10 respiratory filaments and some of the filaments had secondary branches. Also the adult insects did not in any way differ from the flies hitherto known under the name of "Golubac flies". This was really the first finding of *S. columbaczense* in larval stage. Later on the same larvae were found in great numbers in the Danube waters elsewhere, attached to fishing gear at a depth of 6 metres. The larvae were also found in the stomach of sterlets (a kind of small sturgeon), *Acipenser ruthenus*. To show with what avidity these fish feed on *Simulium* larvae, we can quote an example where in a stomach of a sterlet, caught near G. Milanovac on 31. 5. 35, *Baranov* counted 1015 larvae and 6 pupae.

In the course of further studies *Baranov* pointed out that *S. columbaczense* breed exclusively in the region of the "Iron Gate", that is from Golubac in the west to Kladovo in the east. When we take into consideration that the Danube flows for about a 100 km., between these two towns, then we can perceive easily why in certain years we find such a great number of these flies. There is a simple explanation as to why *S. columbaczense* breeds just in that part of the Danube. The river in this part of its course abounds with swift currents and whirlpools. In fact it has three large pools and four canyons through which the river rushes at great and uneven speed. In certain places, according to *Čvijić*, the Danube flows at a speed similar to that of alpine streams, that is more than 4 meters per sec. The great depth of the water, its speed, its chemical composition, its temperature and biocenosis are so special that the same type of this fly does not exist in other parts of the Danube, or in any other river. For these reasons we believe that this species of *Simulium* breeds in big numbers only in these parts of the Danube. *Baranov* has even placed this species in a separate genus under the name of "*Danubiosimulium*". The larvae and pupae of *S. columbaczense* living in these waters possess certain morphological characters which distinguish them from larvae and pupae of any other simuliids, e.g. of those living in other waters than the Danube. These characters are the mouth organs, the number of respiratory filaments, the number of rows and the number of teeth in every row, the placing of the cocoon on the substratum by the larvae, etc.

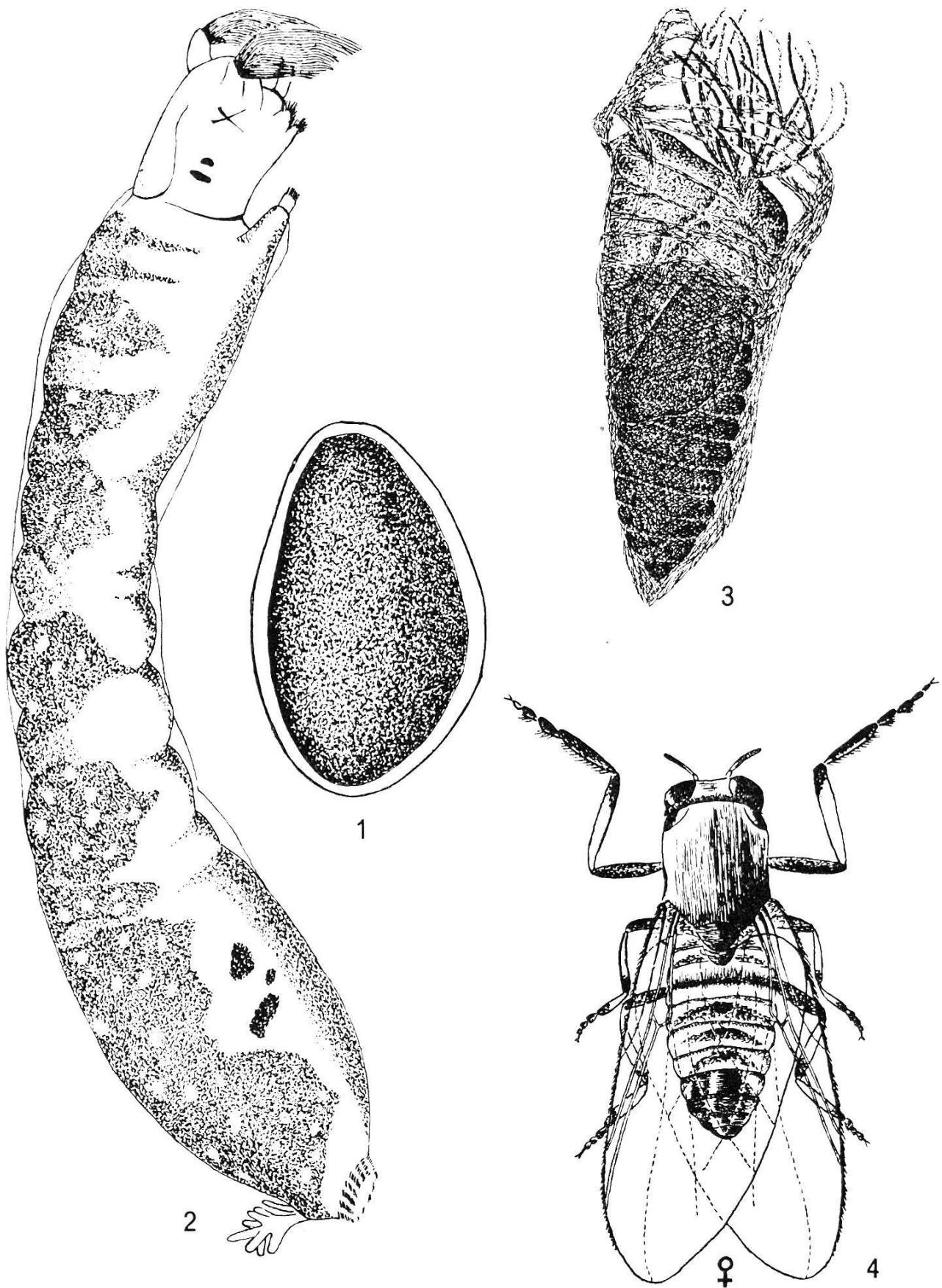


Fig. 1. Simulium columbaczensae.

1 = Egg, 2 = Larva, 3 = Pupa, 4 = Adult female.

The life cycle.

Females of *S. columbaczense*, according to *Baranov*, begin laying eggs in May and the oviposition is completed by the end of June. In order to oviposit, the female insect takes a plunge into the Danube waters and deposits its eggs on rocks, stones or similar objects in a close mass in only one layer. The first larvae appear in late winter or early spring. Thus, it may be said that this species of *Simulium* hibernates in egg stage and this is the longest stage in its development. *Baranov* distinguishes two biological races, viz. *S. columbaczense* "litorale" and "profundale". The first variety is to be found on stones and vegetation in shallow waters and the second on rocks and stones often to a great depth reaching up to 28 meters (e.g. *Gospodjin* Vir. 26-30 meters). This author offers no explanation as to how the larvae of the second variety reached such depths, since in order to lay eggs, the females of *S. columbaczense* would have to be expert deep divers and more so in such swift currents. In our opinion these larvae have reached such great depths through the migration of young larvae hatched out in shallow waters in the same way as the variety "litorale". Now, if this supposition is correct, then the question of varieties could be completely disregarded especially as there are no morphological differences between them. However, apart from this remark, we accept *Baranov's* classification of the two separate varieties. The development of "litorale" larvae variety lasts 3-4 weeks and its pupae 5-7 days. With "profunda" variety both stages are considerably longer since the water temperature in which larvae develop is considerably lower. The first generations of adult insects usually appear during the first half of April and they are related to the "litorale" variety. These early flies do not appear in great numbers nor are they troublesome to livestock. Soon after emerging they are to be met with in thickets and on grass near their breeding places and later on they depart to grazing fields several kilometres away in search for their blood meal among cattle.

Greater invasions of Golubac flies appear during the second half of April and the first half of May and supposedly these belong to the "profundale" variety, which is distinguishable as being of smaller size and of a lighter shade. These flies are very much more aggressive, and according to *Baranov* they are the only variety participating in big invasions that are so disastrous in some years and are the cause of great mortality among livestock.

Only female insects swarm about animals or men and particularly those whose eggs have not yet reached maturity (*Baranov*). By the end of April and in the course of May a great number of these flies can be seen following cattle or men all along the Danube valley (from Golubac to Kladovo). During this period a multitude of these flies can be seen in the windshelters. Male insects never fly away to any greater distance from their breeding places and like mosquitoes feed on plant juices, particularly flowers. Females are most aggressive in the early morning and about sunset. As a rule they attack animals not in masses but rather singly (*Baranov*), though in a short time the whole body may be covered with them, giving an appearance of a thick grey-black smoky cloud around the animal. Dry and warm air is not tolerated by these insects, so during daytime they seek shelter among grass or thickets along brooks, woods or other places with humid fresh air. As soon as any livestock comes near, they emerge from these shelters which also serve them as hiding places against wind or rain.

S. columbaczense gives annually just one generation and as mentioned from the eggs deposited in the previous year. The number of hatched insects greatly varies from year to year and depends on number of eggs laid, high or low level of Danube waters and meteorological conditions during the period of oviposi-

tion. If the number of eggs laid is small, then the appearance of insects in masses is naturally not to be expected. However, even a great number of eggs laid and a great number of hatched larvae do not necessarily mean an abundance of adult insects. Decisive factors are water level in the Danube river, temperature of the water and rainy or windy weather. Mass appearance of Golubac flies should be expected in those years when during April and in the first half of May the water level is low, the air temperature relatively high, the weather generally good without rain. Fortunately enough such favourable years are rather rare, and for the last 30 years, mass appearance of Golubac flies was noted only in 1912, 1913, 1923, 1924, 1929, 1932 and 1934. Especially severe years were 1923 and 1934, when the flies were found over 260 km. from the Danube, their breeding place. In 1934 (April 25th), *Baranov* states that "zone of concentration" stretched for 120 km. along Danube river and for 80 km. to the south. This time there was a rapid increase in number up to 6th of May when they passed to neighbouring counties into the "wider zone", reaching the Kragujevac-Knjaževac line. In the "wider zone" the number of flies remained stationary, whilst in the "zone of concentration" it was progressively increasing till finally great numbers of swarms took their flight. Clouds of flies were carried away by wind, passed over the "wider zone" and turned first in the direction of south-east, then to south and finally to south-west. A small number of flies have even reached into the far south Skoplje (see *Baranov* 1939). On some of these days there were such masses of flies in the air, that they looked like black clouds. In Kragujevac town thousands of dead flies could be seen in front of closed windows after their repeated hard striking at window panes. *Kondić* cites that an airplane had to come down, the pilot having run into a cloud of these flies.

Further advance of flies stopped about 17th of May, the time which coincides with the cessation period for oviposition. The level of Danube water was low during this oviposition period and the rainfall was lower than in normal years, being in April only 42.2 mm., in May 81 and in June 56.5 mm.

For a successful invasion not only a great number of flies is necessary, but their early emergence too. *Baranov* divides invasion of insects into 4 phases. The first phase begins with the hatching period and new flies remain in close vicinity to their breeding places, e.g. the "zone of concentration". In the second phase hatching is continued, and when the first zone is filled up, the surplus passes into the "wider zone". The third phase is the most important and very characteristic, since the insects take up flight into the air just above their breeding places. The fourth and finishing phase is their moving in one or another direction far away (sometimes hundreds of kilometres) from their breeding places.

Mass appearance of Golubac flies and their invasion very often produces disastrous effects not only among habitations along the Danube river, but also in those far away (200 km. or even more). It has been estimated that cattle fatality rate, caused by stings of these flies, is greater in localities farther away from their breeding places than in those in nearer localities, e.g. Niš, Kragujevac against Golubac and D. Milanovac. This can be ascribed not to the relative immunity of the cattle, but to greater aggressiveness of flies, being due to the tedious long journey. Exhaustion and thirst cause the flies, as soon as they leave their swarming multitude, to attack an sting cattle wildly and without restraint. Once the flies have taken up their flight into the air, their invasion is dependent upon the wind direction. Thus Rumania suffered heavily in 1923 and Yugoslavia in 1934. In these years Rumania lost 16,774 head of livestock (mostly cattle) and Yugoslavia only 2,300. The proportion was inverse in 1934 when Yugoslavia lost 12,896 and Rumania only 2,412.

Golubac flies may sting all kinds of animals, but have a predilection for cattle, and their feeding time is before sunrise and after sunset. Some people believe that these flies have a preference for cattle of darker hair and those smeared with dung. Livestock is attacked regardless whether it is in or outside the stables. Flies may enter human dwellings and here they show a preference for women's and children's blood. In man the sting causes pain of greater or lesser intensity, depending upon the site of injury and individual sensibility. At the site of the sting there is a bloodshot mark and intense itching. Accompanying symptoms are pains in the joints, severe headache and insomnia. In the course of the first 24 hours the blood mark still persists, but soon a swelling (3—6 mm. in diameter) with infiltration takes place. After 3-4 days all symptoms disappear, the swelling persisting for a few days longer. Fatal cases are rare.

In livestock the stings may cause grave symptoms which are as a rule fatal. Flies always choose less hairy parts of the animal and by means of their mouth organs cut into the skin, making a depression into which they burrow their heads. While taking the blood meal, drops of blood fall down from the injured skin and at the same time toxic substances are inoculated into the animal. These toxic substances are products of the insect's salivary glands and they produce in the victim toxic symptoms and eventual death. The clinical picture varies in different animals, but is more pronounced with a greater number of stings. The cattle, if attacked whilst grazing, suddenly become restless, kick the ground, wildly swing their tails about and make a dash in search of shelter. Horses, when attacked, stand upright, breathing loudly through their nostrils, but they are less restless than cattle. Pigs keep burrowing into nearby mud or sand. Sheep assemble close together and stamp with their feet. Feathered animals (fowls, geese, etc.) fly to a darker shelter.

The parts most frequently attacked are head, lower parts of thorax and abdomen, mammary glands, scrotum, prepuce and anal region. They may enter nostrils, mouth, ears and under eyelids and the injured part becomes swollen and hard. The swelling gradually spreads and is painful to palpation. If an animal is stung by a great number of insects, it refuses to take food and looks miserable, but in more severe cases there occurs ventricular paralysis accompanied by meteorism and occasional diarrhoea. Chills with hairs standing up, difficulty in breathing and general malaise are the symptoms pronounced from the very beginning. The pulse is rapid and frequently irregular, though in most cases there is no rise of temperature. Milk secretion is either diminished or stops completely and abortions are frequent. Flies that have penetrated mouth cavity or nostrils may cause oedema of the glottis leading to asphyxia. They may even reach into trachea and bronchi. In severe cases death ensues within 30 minutes to 2 hours, resembling closely apoplexy. In lighter cases a complete recovery usually follows within 1-2 days. The animals which survive show a fair degree of immunity (according to *Vuković*) to renewed attacks of Golubac flies.

The treatment is symptomatic. Peasants give whisky (*šljivovica*) or coffee by mouth and smear the swollen parts with whisky or vinegar. Veterinarians, if they reach in time, apply cardiacs and symptomatic remedies.

On the autopsy, the following changes are to be found: serous infiltration of subcuticular tissue, haemorrhagic patches on mucous membranes of the respiratory organs, pulmonary oedema or traumatic bronchopneumonia caused by flies within the bronchi, subendocardial and epicardial ecchymosis, haemorrhages within intestinal mucous membrane and enlarged spleen (*Vuković*). A great number of flies may be found all along respiratory tract up to bronchi.

Prophylaxis.

The control of Golubac flies in view of their life cycle is a very difficult one. Their breedings in the Danube over an area over 100 km. and at a depth reaching up to 26 metres, makes the control still more difficult. The only thing that could be done is to breed and multiply their natural enemies like sterlets which, as afore said, eagerly devour larvae of the flies and are really their favourite food. The control of newly hatched insects, in our opinion, could not give satisfactory results on account of their being widespread over an area covering several hundreds of kilometres in thickets and grass. The control of swarms during their invasion is not feasible. Aerosol spraying by airplane, so far, has not been tried.

Although we know that the cause of death is due to the injected toxin, we know little as to the nature of these toxic substances, nor do we know any means of neutralizing them. Reconvalescent animal sera have been tried, but these have shown neither curative nor preventive beneficial effect. The only preventive measure left to us is safeguarding against stings of these flies. It is best achieved by removing cattle and other livestock to remote places during the period of fly activity or by using insect repellents, such as petroleum, turpentine oil, vinegar, coal tar ointments or other smelly substances. Animals should be smeared over the most tender parts of the body and grazing time should be changed accordingly. *Baranov* recommends a mixture of vaseline, ol. petrae with naphthaline solved in paraffin oil. Any smearings are but of short duration and their price is not inconsiderable. Perhaps the simplest way is that during the invasion period cattle should be strictly kept in stables and from time to time smoky fires should be made. Peasants have their own way: one may frequently see an oxen team pulling a plough and from the yoke as a measure of precaution, hangs a can with burning charcoal. This measure is not very satisfactory and we think the better policy is to lose rather a few days work than cattle.

Simulium columbaczense is a great problem in this country, and therefore a laboratory centre with a complete meteorological station has been installed at Golubac. Two other meteorological stations are planned, one being at D. Milanovac and the other at Kladovo. Aims of these laboratories and stations are to follow development and movements of Golubac flies and to give warnings and reports in the right time by wireless or other means.

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