ON THE ACRIDIOPHAGOUS SARCOPHAGIDAE OF BRITISH COLUMBIA WITH RECORDS OF ALL OTHERS TAKEN IN THE PROVINCE

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Introduction

In 1934 Howard Curran (4) proposed the name Metopiidae, to include in the family "all the flies previously known as Sarcophagidae, part of the Muscidae and part of the Tachinidae of Williston's Manual, which is apparently a natural association as proved by a study of larval and pupal characters."

The larvae of the Metopiidae are either scavengers or flesh feeders, parasitic chiefly on invertebrates, especially insects. A few are sometimes myiasis-producers on vertebrates. Apparently all the members of the old family Sarcophagidae are larviparous but within the family Metopiidae as now constituted, there is, even in this Province, a nice gradation in methods of reproduction from truly larviparous flies to those that lay eggs which hatch almost the instant they are extruded, others the eggs of which hatch within 10 seconds or so, and yet others the eggs of which may require as long as 24 hours to hatch. All the maggots of the Sarcophagidae *sens. strict.* have the posterior spiracles situated within a deep depression. For the most part, the flies have two silvery-grey stripes and three black stripes on the thorax and have tesselated abdomens; the antennal arista is plumose above and below for only half of its length, and the vein M_1 bends strongly forward towards R_{5}, although the apical cell is almost always open.

The classification of the Metopiidae, as Curran says, is in a chaotic condition because "a great many genera have been proposed upon characters possessed by one sex or the other and upon characters which are apparently of not more than specific or group value, which are found to be entirely unsatisfactory when large collections are studied." Townsend especially has produced a bewildering array of generic names: in the 54 species with which we are concerned in this paper, he has proposed 16 new genera — all ignored by Curran (4), and Brues, Melander and Carpenter (2). Curran's family Metopiidae now includes such well-known but diverse forms as the common blue and green blowflies, the black blowflies that attack sheep, those that parasitize nestling birds, the cluster fly that attacks earthworms, and the true Sarcophagidae. For the sake of simplicity we are using here the nomenclature of Aldrich (1) with a few more recent changes but indicating in brackets Townsend's generic grouping and nomenclature.

The habits of attack of these Sarcophagidae vary from those of *Wohlfahrtia vigil* and *W. meigenii* (*Paraphyto opaca*) which larviposit on the very young of wild and caged mammals such as mink, and sometimes on babies; *Sarcophaga citellivora* which attacks ground squirrels; *S. magna* which attacks the western striped June beetle *Polyphylla perversa; S. eleodis* which attacks the large black darkling beetles; *Agria affinis* and *S. tuberosa sarracenioides* which parasitize caterpillars of butterflies and moths, including the spruce budworm; to *S. l'herminieri* which develops in carrion and dung, chiefly cow manure, the commonest and most widespread species in this Province and most of the northern part of the continent (1).

This paper is based on British Columbia records of Sarcophagidae from the Canadian National Collection at Ottawa, the collections at the University in Vancouver, the Dominion Entomological Laboratory at Kamloops, and from literature (3) (5) (7).

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The field observations, rearing experiments, identifications, records of distribution and writing of this paper, were done by G. J. Spencer, and the mass cage rearing, making of the Kamloops collection and preliminary lists of Sarcophagidae, by E. R. Buckell (3).

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BRITISH COLUMBIA RECORDS OF SARCOPHAGIDAE TO APRIL 1957

Emblemasoma erro Ald.

Wohlfahrtia vigil Walk. Iden. H. J. Reinhard. Quesnel. Rare.

Paraphyto opaca Coq. (*W. meigenii* Schiner). Nicola, Kamloops, Vernon, Chilliwack, Vancouver.

Brachycoma devia Fall.

B. sarcophagina Towns.

Agria (*Pseudosarcophaga* Kramer) *affinis* Fall. Monashee, Robson, Salmon Arm, Lumby, Vancouver.

Sarcofahrtia ravinia Park. (*Thelodiscus indivisus* Ald.) Chase. Rare.

Senotainia flavicornis Towns. Chase, Kamloops. Rare.

Blaesoxiphotheca (*Sarcophaga* Meig.) *coloradensis* Ald. Common at Kamloops in 1954 when most other species were absent; Chilcotin.

B. caudata Towns. Females abundant at Lytton in 1931 "not referable to species without males" (D. G. Hall).

Acanthodotheca Towns. 2 spp. undet. of this genus from B.C. in C.N.C.

Helicobia rapax Walk. (*Sarcophaga helicis* Towns. Ald.) The prevailing fly attacking *M. bilituratus* at Lytton in 1931; one of the earliest sarcophagids of the season. Nicola, Kamloops, Lytton, Robson. Reared also from the longicorn *Ergates spiculatus* Lec. at Kamloops.

Metoposarcophaga importuna Walk.

Ravinia pusiola (Van der Wulp). Robson.

R. stimulans (Walk.) (*quadrisetosa* Coq.). Robson.

Sarcophaga (*Sarcotachinella* Towns.) *sinuata* Meig. Lytton, Kamloops, Robson, Skidegate.

S. (*Boettcheria* Park.) *latisterna* Park. Vancouver.

S. (*Boettcheria* Park.) *cimbicis* Towns. Quesnel, Kamloops.

S. (*Boettcheria* Park.) n. sp. near *latisterna* (Det. Curran) in C.N.C. Seven places in B.C.

S. (*Fletcherimyia* Towns.) *fletcheri* Ald. Robson.

S. (*Tephromyiella* Towns.) *atlanis* Ald. Kamloops, Stump Lake, Nicola, Robson.

S. (*Protodexia* Towns.) *hunteri* Hough. The prevailing gropper parasite in 1954 at Kamloops; Lytton, Robson.

S. (*Stenaulacotheca* Town.) *spatulata* Ald.

S. (*Opsophyto* Towns.) *opifera* Coq. The most abundant sarcophagid in the dry belt; Kamloops, Nicola, Chase, Vernon, Lytton.

S. (*Eleodiomyia* Towns.) *eleodis* Ald. Kamloops, Robson.

S. (*Kellymyia* Towns.) *kellyi* Ald. Irregular in occurrence but abundant when present. Lytton, Kamloops, Kelowna, Nicola, Robson.

S. (*Zygastropyga* Towns.) *sulculata* Ald. Vancouver, Kamloops. Very rare.

S. (*Bercaeopsis* Towns.) *wrangeliensis* Park.

S. (*Bercaeopsis* Towns.) *vancouverensis* Park.

S. (*Acridiophaga* Towns.) *setigera* Ald. B.C.-Alberta boundary.

S. (*Acridiophaga* Towns.) *falciformis* Ald. Kamloops, Robson.

S. (*Acridiophaga* Towns.) *savoryi* Park.

S. (*Acridiophaga* Towns.) *aspertella* Park.

S. (*Acridiophaga* Towns.) (*Metoposarcophaga*) *tothilli* Park.

S. (*Metoposarcophaga*) *incurva* Ald. Robson.

S. (*Robineauella* End.) *juliaetta* Ald. Shuswap Narrows. Very rare.

S. (*Robineauella* End.) *occidentalis* Ald. Vancouver. Rare.

S. (*Robineauella* End.) *tuberosa* var. *exuberans* Pand. Nicola, Kamloops, Robson. Uncommon.

S. (*Robineauella* End.) *tuberosa* var. *sarracenioides* Ald. Lytton, Kamloops.

S. (*Robineauella* End.) *tuberosa* var. *harpax* Pand. Lytton, Nicola, Kamloops, Hat Creek, Chilcotin, Alexandria. Common.

S. (*Robineauella* End.) *nearctica* Park. (*scoparia* Pand.). Vancouver, Kamloops, Robson. Scarce.

S. (*Robineauella* End.) *bullata* Park. Kamloops, Vancouver.

S. (*Robineauella* End.) *cooleyi* Park. Chilcotin, Robson. Very rare.

S. plinthopyga wiedmann (*robusta* Ald.). Reared in Vancouver from mammal skulls sent from Mexico. There is a specimen from Seattle in U.S.N.M. (Aldrich) so it may occur naturally in B.C. also.

S. insurgens Ald. Kamloops, Chase. Scarce.

S. magna Ald.

S. haemorrhoidalis Fall. Vancouver. Rare.

S. thatuna Ald. Nanaimo. Rare.

S. (*Miltoravinia* Towns.) *planifrons* Ald. Kamloops, Nicola.

S. (*Euravinia* Towns.) *l'herminieri* Robineau-Desvoidy. Widespread and common; Kamloops, Nicola, Robson, Cariboo, Vancouver.

S. (*Chaetoravinia* Towns) *latisetosa* Park.

S. (*Acridiophaga* Towns.) *reversa* Ald. Very common at Kamloops, merely occurs in the Nicola.

S. (*Acridiophaga* Towns.) *uncata* Van der Wulp (*marginata* Ald.) Kamloops. Rare.

S. (*Acridiophaga* Towns.) *caridei* Brethés (*angustifrons* Ald.). Kamloops. Rare.

S. (*Acridiophaga* Towns.) *aculeata* Ald. Lytton, Kamloops. Scarce.

S. (*Acridiophaga* Towns.) *aculeata* var. *taediosa* Ald. The prevailing variety of *aculeata* in B.C. Kamloops.

S. (*Acridiophaga* Towns.) *aculeata* var. *gavia* Ald. Kamloops. Rare.

S. (*Acridiophaga* Towns.) *aculeata* var. unplaced because no males; very many females; Kamloops, Pritchard, Trap Lake, Midway.

Of these 54 identified species, all but the following 13 in the Canadian National Collection are represented in the collections at the University of British Columbia. Most of the University specimens were collected by G. J. Spencer: *Sarcophaga aspertella, Brachycoma devia, Blaesoxiphotheca caudata, Emblemasoma erro, Metoposarcophaga importuna, S. magna, S. occidentalis, Ravinia pusiola, Brachycoma sarcophagina, S. savoryi, S. tothilli, S. vancouverensis, S. wrageliensis.*

Biology

In connection with the grasshopper parasites some terms should be defined. A grasshopper is a member of the family Acridiidae, or short-horned, jumping Orthoptera; a hopper is the flightless nymph of a grasshopper; a locust is a short-horned grasshopper which regularly, or irregularly, congregates and migrates in a swarm (8). To indicate an orthopteroid population of any combination of flying adults and flightless nymphs of several to many species, I propose, and will employ the term "gropper". There are no true locusts in this Province in normal years, but one species, *Melanoplus bilituratus* (Walker), hitherto (6) called *Melanoplus mexicanus mexicanus* (Saussure), remains a localized grasshopper for 7 to 9 years and then increases to outbreak proportions. At such times the species may undertake locust-like mass flights for short distances, or for several to many miles. Apparently *M. bilituratus* is closely related to *M. spretus* Walsh, the notorious Rocky Mountain locust, a long-winged race which arose on the eastern slopes of the Rockies and migrated eastwards as far as the valley of the Mississippi from 1868 to about 1870. *M. bilituratus* is widespread in B.C., but becomes a serious pest periodically and only in the dry belt (7).

Another even more widespread acridiid is *Camnula pellucida* Scudder, the roadside grasshopper, which also develops to outbreak proportions but never becomes a locust, although it may scatter for wide distances from its developmental centres (7).

Practically all our parasite work has concerned these two species, especially the relationship of the sarcophagids to *M. bilituratus*. Of the 54 species of flies listed, the developmental habits of 27 are unknown, 14 have been bred from groppers at Lytton or Kamloops, and two species recorded elsewhere in North America as gropper parasites have been captured by us locally but not reared. One of the latter pair, *Acridiophaga caridei* is of particular interest. It is generally present in Argentina and Uruguay as a parasite of the gregarious locust *Schistocerca paranensis* Burmeister. From both these countries collections of larvae have been made by British workers and sent for colonization to the parasite laboratory at Belleville, Ontario. Canadian workers have reported that this is a very active and agressive fly, most suitable for building up populations under laboratory conditions. Many specimens have been liberated in Ontario. As far as our experts can tell, the identical species is found in this Province. We have captured a few specimens in the field near Kamloops but have never recovered *A. caridei* from the many thousands of groppers we have caged.

The 14 species or varieties which we have reared from groppers captured alive in the field and maintained in

large rearing cages for parasite recovery, are: — *Blaesoxiphotheca coloradensis, Helicobia rapax, Sarcophaga sinuata, S. aculeata, S. aculeata* var. *gavia, S. aculeata,* var. indeterminable, *S. falciformis, S. reversa, S. kellyi, S. tuberosa* var. *exuberans, S. tuberosa* var. *sarracenioides, S. tuberosa* var. *harpax, S. opifera, S. hunteri.*

On the hills of the dry belt, 16 species including these 14, may be found in some seasons. All of them have certain habits in common as we have determined repeatedly by experiments conducted from 1931 to 1946 and in 1954. The flies occur unpredictably, abundant one day and absent the next, turning up suddenly in an area where they have never been taken previously, occurring in countless thousands in an area in the autumn and absent next spring; literally, they occur where you happen to find them.

Speaking of the 14 acridiophagous species as a group, the following summarizes the habits that these flies have in common:

1. Groppers in the dry belt of British Columbia follow a fairly regular 7- to 9-year cycle of abundance and recession. In any area subject to attack by *M. bilituratus,* unless the cycle has been upset by control measures, the course of the cycle can be determined by the presence or absence of parasitic flies, and by comparing the relative numbers of hosts and parasites. An infestation with few or no associated parasites, is on the increase, and where parasites are abundant the host is in peak numbers, probably near the top of the curve or cycle, or just past it. By actual count, the proportion of flies to groppers may be 77 to 100, and in damp, grassy hollows, there may be more flies than groppers. Where this happens, in the next season the gropper population falls like a plummet.

2. All the species of sarcophagid flies concentrate upon *M. bilituratus,* our most agile, aggressive, harmful, and widely distributed gropper. There may be a dozen species of groppers present including a vast number of *pellucida,* but the highest sarcophagid parasitism obtained to date in *Camnula* has been only 6 per cent, and minor species may be unparasitized; *M. bilituratus* bears the brunt of the attack.

3. Nineteen species of sarcophagids have been experimented with on gropper-infested areas, 5 species not being parasites, and in *all* of them there exists an impulse activated apparently by visual stimulus, to pursue a small moving object. This was first determined in 1931 when the flies darted at inch-long pieces of alfalfa stems flicked with thumb and finger over them. Later on bits of wood the size of a gropper body were used but it was soon discovered that such shape and size were not essential in evoking the impulse; the flies would pursue small pebbles or even rolled-up pieces of paper. The impulse occurs in both sexes, but in the case of males, it is probably a sex urge for in the early part of the season when male flies only are present in an area, they will dart at everything within their range of vision.

4. The flies sit on objects just above the general ground level, such as stones or lumps of cattle and horse manure, and from these vantage points pursue groppers that jump or fly from near them. They strike the groppers from above, seemingly at the junction of thorax and abdomen between the wings, and return to the perching place. Given an even distribution of groppers, a field of stones suitable for perching places will have more flies in it than a grassy field without stones; a calm area will contain more flies than a windswept one, and the ultimate parasitism in a hollow will be much higher than in a windswept area.

In a stoneless area of short grass, infested with groppers and with considerable numbers of flies, three types of perches were tested: very dark, old burlap sacks; clean, light brown burlap sacks; and white flour sacks. These were spread at uniform distances over the sod. In a very few minutes the flies averaged 0.1 on the

dirty old sacks, 4 on the clean brown sacks, and 10 or 12, and up to 20 on the white flour sacks. From these vantage points the flies pursued passing groppers, returning to the sacks after each trip.

Anything which disturbs groppers in an area causing them to leave the ground, results in increased parasitism. Domestic animals, especially grazing sheep, cause groppers to jump or fly and the sarcophagids then parasitize them. No instance has been noted of any of these 14 species of flies larvipositing on a gropper on the ground; the host must be either jumping in the case of a nymph, or flying. During one season, in the heat of the day when groppers normally do not fly, with *pellucida* groppers present in large numbers and flies of the *aculeata* complex abundant, the flies persistently bullied and buzzed at the groppers on the ground until they were forced to fly to escape the bullying, whereupon the flies struck at them. This harassment occurred for some time that year but has never been seen since.

5. The urge to chase a moving object results in female flies impartially pursuing *all* species of groppers in an area, both large nymphs of the 4th and 5th instars and adults, whenever these occur together.

6. As far as the human eye can perceive, there is physical contact between fly and gropper and *presumably,* a living larva is deposited. This seems to occur even when a small stick is flicked over a fly watching from its perch. But flies learn fast; if a succession of sticks is flicked over with a noticeable pause between each one, the first piece is apparently hit; the second time the fly stops a few inches short of it; the third time the fly may be 2 or 3 feet short of it, or merely fly a few feet off the perch, and back again.

Certain questions arise here: Does a fly deposit a maggot every time it strikes a gropper? Since flies appear to strike groppers indiscriminately, why is *M. bilituratus* alone so heavily parasitized? Conversely, why is *C. pellucida* apparently and markedly, almost immune from these flies?

To answer the first question, flies were collected just after they had pursued and apparently "struck" a gropper. Careful examination led to several conclusions: In the early part of the season and sometimes later, the fly was a male. Sometimes the gonads of the fly were immature, indicating that the pursuing impulse was not the result of a hormone secreted only at reproductive maturity. Sometimes the reproductive system was mature with a maggot ready in the common oviduct like a torpedo in a tube; apparently the fly had struck without discharging the maggot. This happened not infrequently when groppers were very active and when flies struck repeatedly. Presumably the flies had not time to discharge their maggots before the visual impulse impelled them to attack again. Sometimes when the reproductive system was mature, the common oviduct was empty, indicating that the maggot had just been discharged. This condition occurred many times when flies were active in a swarm of groppers. The visual impulse to strike had occurred before the next maggot was in place ready for discharge. It was not possible to determine exactly how fast and at what intervals a fly could discharge a succession of maggots. Even when a fly had discharged all its maggots, sometimes it apparently followed the impulse to strike until it died. The supply that a gravid and really fat fly (*aculeata* complex) had on hand, was 120 maggots, 60 in each ovary, all the maggots of uniform and apparently mature development.

To further check this question, groppers were collected and examined immediately after being struck by flies. This was done many times but never was a maggot found *on* a gropper's body and, to judge from experiments reported here, it was unlikely that the maggot had penetrated in the few seconds it took to collect the

struck gropper. Unfortunately, the surface of the fan-like meta wings was not examined; it is possible that the maggots were deposited on the wings and left to penetrate the groppers later.

To answer the questions as to why *M. bilituratus* is particularly susceptible to attack by species of sarcophagids, and *C. pellucida* practically immune, both species of groppers were watched under attack in the field and laboratory, and experimentally struck to see if and how the maggots penetrated.

In the field, the behaviour of both *M. bilituratus* and *C. pellucida* differs according to the pressure of population, and the presence or absence of temporary migratory impulses. In dense populations there is, almost daily, a heavy local migration between feeding points. Groppers are freely attacked by flies as they get up from the ground, and sometimes the flies actually travel along with swarms out of which they have been captured by net. Under these conditions of seething populations, groppers do not seem to notice the flies at all, although the latter strike them freely.

In populations near the bottom of a cyclic curve, when groppers and flies may still be fairly numerous, both *M. bilituratus* and *C. pellucida* generally cut short their flight when struck, and pitch down, or nose-dive to the ground, and then assiduously clean their bodies as if in a conscious effort to free themselves of maggots. In the process the body is scraped with all the legs as thoroughly as a bee cleans herself, and the wings are opened and closed rapidly and then held aloft while fully open and rubbed down with the hind legs. The chances of a delicate maggot surviving such brushing seem remote. This behaviour on the part of struck groppers would tend to allow the establishment of more maggots in peak years when groppers do not pitch down and clean themselves, and fewer maggots during low populations near the bottom of the cycle when groppers take time to groom themselves.

In the laboratory, specimens of both species were immoblized, and first instar maggots were placed on their bodies. The procedure was as follows: flies were swept from vegetation in the field, treated with just enough chloroform, ether, or cyanide, to cause them to lose their balance and fall over. The abdomens of heavily gravid ones were then gently pressed with forceps and the fully formed maggots squeezed out. Sometimes pressure was not necessary and the maggots streamed out themselves. (There is a fine point at which it is possible to kill the flies and still have living maggots emerge. Once, a number of *S. kellyi* taken for pinning were cyanided and kept overnight in a salve box; next morning many small maggots were active in the box; they had consumed the contents of their mothers' bodies leaving only the body walls. When given a succession of freshly beheaded grasshoppers, they fed on these, reached maturity, pupated and emerged as flies.) When enough maggots were pressed out of a fly, they were held on a microscope slide until required, in a large drop of human saliva, which has been found a better medium than water or normal saline. Test groppers from an area of little or no parasitism were then immobilized in a row on a strip of wood by thin strips of scotch tape or adhesive, leaving exposed and readily accessible the particular portion of body needed. A maggot was picked up with the tip of a needle, or a very fine camel's hair brush wetted to a point, and placed on a selected part of the captive gropper.

Maggots of several species, chiefly *S. aculeata, S. reversa, S. kellyi,* the *S. tuberosa* trinity, *S. opifera* and *S. l'herminieri,* were placed on gropper bodies in various locations from the cervix to the anus, but not once was a maggot of any species observed to penetrate the inter-segmental membrane. The maggots were placed with only the viscous fluid from the parents' glands or without any fluid at all, or in drops of water or saliva, but none succeeded in penetrating the integument, or

the spiracles, although all made drilling movements with their minute mouth-hooks.

Only one spot on the gropper's body was readily and easily penetrated by 1st instar larvae, and that was the tympanum or auditory organ on the first abdominal segment. Most tiny maggots penetrated it in from 10 to 30 seconds, generally nearer 10 seconds. This occurred either when the maggot was placed directly on the tympanum or when it happened to cross the tympanum in the course of its wanderings. The maggot always quickly disappeared from view, the gropper seemed none the worse for the incision, and the parasite developed normally.

Many maggots have been introduced into gropper bodies by making minute incisions with sharp dissecting needles or minute scalpels, and placing the larvae in the small drops of blood which welled up from the wounds. The blood had a stimulating effect on maggots; they increased the activity of their mouth hooks and very quickly penetrated the wound. Maggots were inserted into a gropper by placing them on the stump of a freshly severed leg; but in most cases after the amputations the groppers died within a few days. Once an even hundred *S. reversa* larvae were readily introduced into 100 *C. pellucida* through abdominal incisions, but no maggots became established. Perhaps the blood of *C. pellucida* itself was hostile to the maggots, although the maggots entered the incisions readily enough. The wounds were of secondary importance to the host.

The maggots of one species of fly, *S. l'herminieri* were repelled by the blood of a gropper into which they were actually shoved several times. Even when they were inserted directly into the gropper's body cavity they quickly came out again. Finally, when placed on fresh rabbit intestines they completed their growth and emerged as adults.

Another question arises: "Do maggots kill their hosts, and if so, how?" It has been noted in many places on the dry belt ranges that, in restricted areas, flies have been so numerous as apparently to outnumber their hosts; on the face of it, it would appear that not one gropper would reach the end of the season. The only certain way of determining parasitism is to dissect the host; but dissection kills the host and, unless it is full grown, the maggot also dies. Moreover, maggots of the smaller species of flies such as *H. rapax* and *S. opifera,* may occur two and three, or as many as nine to a gropper. Maggots of larger flies need one gropper apiece for their development.

If one maggot of a small fly like *S. opifera* should occur in a large, fat female *C. pellucida,* it does not necessarily kill the host. On one occasion a *Camnula* was watched while she laid an egg pod; immediately after a maggot emerged from her abdomen while the gropper hopped normally away. The fly was reared and turned out to be *S. opifera.*

We have seen that the hazards the tiny sarcophagid maggots have to pass before they can enter a gropper are considerable. Granted that one has safely entered a host — what happens? To answer this question, a long series of groppers were dissected and records kept of the condition of their body contents. For most of its growth period a larva apparently feeds on blood alone, then the fat body diminishes first through being starved, and later, apparently, by being consumed. In some cases the fat body remains intact but as a starved, thin membrane, and in this condition it is easily overlooked. Also at first examination, it would appear that the female reproductive organs are consumed, but again, careful examination shows them, apparently undeveloped and juvenile, but in reality, starved in a bloodless body cavity almost to the point of absorption. The ovarioles are present, but so small as to be easily overlooked. Often at this stage,

the maggot emerges from the bloodless host, which soon succumbs. The maggots of larger flies, however, such as the *Blaesoxiphotheca* and *S. tuberosa* groups, requare the entire contents of the hosts, and when they emerge, the bodies of the hoppers are mere shells, and one can literally whistle through them.

Apart from the academic interest of this whole problem which has been condensed here almost to the point of detached statements, the practical application of the matter lies in these questions: If these Sarcophagid flies kill groppers readily and *sufficiently* to prevent cyclic increase, can the flies be reared in a parasite laboratory, kept in cold storage, and liberated where necessary to control a similar outbreak? Can we utilize them in the same way as some hymenopterous parasites are utilized?

Omitting the details of other experiments we can conclude: Of the groppers in British Columbia subject to periodic, cyclic increase, *M. bilituratus* is the only species which is very heavily attacked by 14 species of sarcophagids. Of these 14 species of flies, *S. kellyi* alone can be reared to maturity from expressed first instar maggots on a succession of immobolized or partly crushed groppers. The maggots can be fed fresh, beheaded hopper bodies daily or every other day, will readily complete their growth as maggots and will pupate; the pupae can be stored over winter. This is virtually a saprophagous trait as Mr. R. W. Smith found in the parasite laboratory in Belleville, Ontario, (personal communication) and yet in British Columbia, *S. kellyi* has sometimes proved a most aggressive and successful field parasite against outbreaks of *M. bilituratus*.

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