Summary

We show that there are correlations in regenerative fresh water planarians between all the parts of the body. When planarians are wounded in any part of the body, this mutilation will set regenerative cells in movement, which are able to travel a very long way in their migration. The extent and the speed of migration haves been shown by the method of localized X-ray irradiations.

When the regenerative cells that are nearest to the wound have been killed with X-rays, regeneration occurs through the access of cells from the farther parts of the body. The nature of the stimulus is not yet known.

On Temperature Regulation and Metabolism in the Swift, *Micropus* a. *apus* L., during fasting

As a part of a more comprehensive investigation concerning the ecology and physiology of the swift, *Micropus* a. *apus* L., a series of experiments was carried out in order to explain how this species, bound to feed on the insects in the air, can survive during a fast caused by a protracted period of bad weather. In the following, an account of the most important results of this preliminary experiment is given.

As experimental animals young swifts aged about 4–5 weeks and breeding adult swifts were used. Immediately after being taken from the nest they were placed in separate glass vessels. No nourishment or water was given during the experiment. Each bird was weighed every hour, likewise the body temperature was measured once an hour. Weighing was carried out with ordinary analytical scales. In measuring the body temperature a thermocouple was used. The body temperature was measured in the throat. The metabolic rate was determined by means of the well-known method of HALDANE, modified by KENDEIGH[1].

Table I

Environmental temperature (°C)	Survival time (hours)	
	Adult	Juvenile
19	100	150, 175
24	100, 100, 120, 135	205, 210, 220, 290
30	110	—

At 24°C the survival time of young swifts (Table I) is on an average about 230 hours (about 9 days). It is, however, to be noted that this value was obtained under unnatural experimental conditions, in which the birds, for the sake of the different measurements, were regularly disturbed. This causes, of course, a decrease in hunger resistance. According to HUGUES[2] 2 young swifts, kept in complete quiet, were able to fast 13 or even 21 days. BREHM[3] mentions a fast of 6 weeks, the origin of this report, however, not being given. – The young of the small insectivorous birds are generally known to be very sensitive to lack of food. A fast exceeding 2 days may be quite exceptional (compare GROEBBELS[4], p. 571).

[1] S. C. KENDEIGH, J. Exp. Zool. *82*, 419 (1939).
[2] A. HUGUES, Bull. Soc. zool. France *32*, 106 (1907).
[3] BREHMS Tierleben, 8 Bd. (Vögel: 3. Bd.) (4. Aufl., Leipzig u. Wien, 1911), p. 307.
[4] FR. GROEBBELS, Der Vogel, I (Berlin 1932).

Table II

	Adult		Juvenile		Diff. of means
	Limits	Mean	Limits	Mean	
Initial weight (g)	40·0–45·3	42·2	43·5–53·3	49·2	7·0
Weight at death (g)	25·1–28·3	26·1	19·4–24·9	23·2	2·9
Weight loss (g)	14·5–18·7	16·1	18·9–30·4	26·0	9·9
Weight loss (% of initial weight).	26·3–41·4	38·1	43·4–59·5	52·5	14·4

The ability of adult swifts to resist hunger is remarkably lower, though it exceeds markedly the general resistance of smaller birds. The adult birds used in the experiments generally died after a fast period of 110 hours (4 days).

At 24°C *young swifts are able to fast about 120 hours (5 days) longer than the adult individuals.* This peculiarity

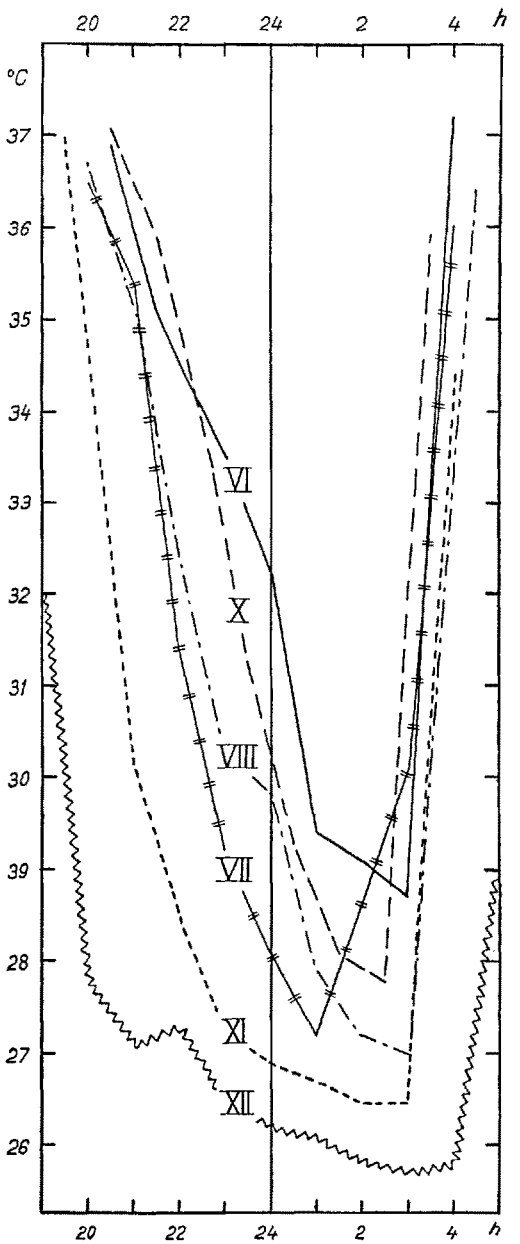

Fig. 1.

is evidently caused by the fact that a young swift still lying in the nest is, under normal conditions, remarkably heavier than the adults. As seen in Table II, the mean weight of the young at the beginning of the experiment was 49·2 g, while the adult swifts weighed only 42·2 g, a weight agreeing with the normal weight of adult swifts (e.g. WEITNAUER[1]). Thus, the young had a weight surplus of, on the average, 7·0 g, evidently available for use during fasting.

The mean weight of the young at death was 23·2 g, that of the adults being 26·1 g. Thus, the young had in fact 7·0 + 2·9 = 9·9 g more available food deposits than the adults. By this means, the average total weight loss of the young, during the experiment, was about 10 g greater than that of the adults. While fasting, the young swifts are able to utilize at least half (on an average 52·5 %) of the total body weight. The weight loss of the adults agrees with the normal weight loss producing death in birds (GROEBBELS, op. c.)[2]

In the first few days, the body temperature of fasting swifts fluctuates within the limits of the normal physiological rhythm (compare e.g. HILDÉN and STENBÄCK[3], BALDWIN and KENDEIGH[4]). After a fast of a certain length, however, *they lose the capacity for temperature regulation and change in their thermal reactions like poikilothermic animals.* During the diurnal sleep period, the body temperature falls, being, in markedly developed hunger conditions, only 2–3°C higher than the environmental temperature (in different experiments varying from 18·5 to 30°C).

Fig. 1 illustrates the body temperature of a young swift in a fairly deep hunger coma, between the 6th–12th fast-nights. The body temperature of the young swift in the resting condition is rather low (38–39°C). This value lasts till the early afternoon, whereupon the body temperature gradually begins to fall, and the bird is sunk

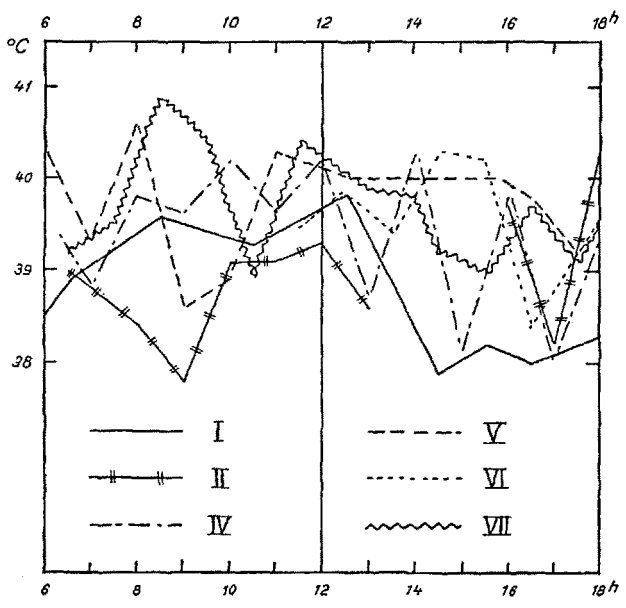

Fig. 2.

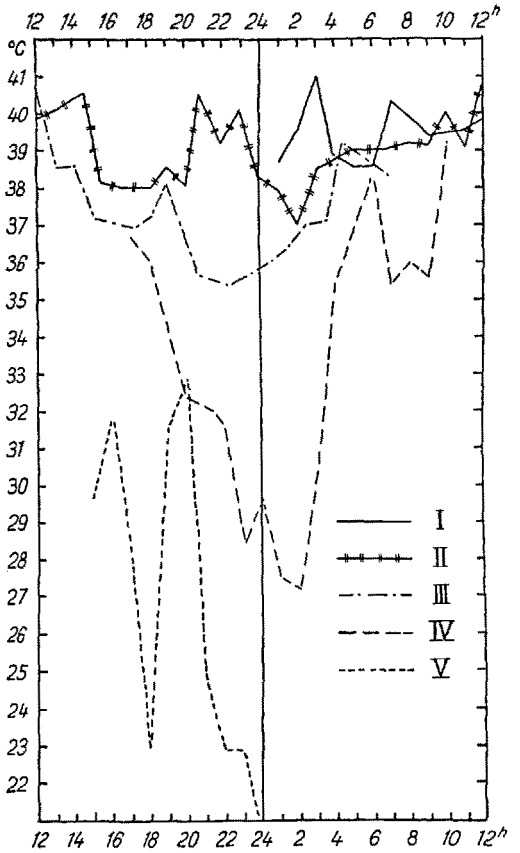

Fig. 3.

in coma. The minimal body temperature is reached between 1 and 3 a.m., after which time recovery of consciousness and a rise in the body temperature take place very rapidly. Each night over a longer period (in this case about a week) the body temperature falls to 25–29°C, the environmental temperature being 24°C. In an environmental temperature of 19°C, on the 7th fast-night, a body temperature of 20·1°C was measured.

After the bird recovers consciousness, the body temperature rises regularly to the normal day rate or at least close to it. The period of high body temperature, however, diminishes from day to day.

The mechanism of temperature regulation in adult birds is disturbed more easily (Fig. 2). Later on, the fall in body temperature to the critical limit takes place, likewise, more rapidly and without a distinct period of reversible coma (Fig. 4).

Along with the loss of the capacity for temperature regulation the whole metabolic rate changes in a manner corresponding to that of poikilothermic animals. The rate of breathing, under normal conditions about 40 times/min, falls to 10 times/min. Fig. 4 shows the carbon dioxide output during coma. In an entirely corresponding manner the oxygen consumption, the water loss, and the body weight loss fall remarkably. In an awakening young swift the average body weight loss is 100–150 mg/hour. In the deepest reversible coma the weight loss falls to $^1/_{10}$ of that.—The awakening from the coma generally occurs very rapidly, in some cases even in about 20 minutes. A waking—in particular a freshly awakened—swift is exceedingly energetic and forceful.

The practical significance of the coma condition, described above, may, by lowering the energy requirements, be very remarkable. Under natural conditions the

[1] E. WEITNAUER, Orn. Beob. *44*, 133 (1947).

[2] It should be mentioned that in HUGUES' (op. c.) experiments, in which the birds were in absolute quiet, the weight loss was 62 and 63% of the initial body weights (57 and 68 g resp.).

[3] A. HILDÉN and K. S. STENBÄCK, Skand. Arch. Physiol. *34*, 382 1916).

[4] S. PRENTISS BALDWIN and S. C. KENDEIGH, Sci. Publ. Cleveland Mus. Nat. Hist. *3*, 1 (1932).

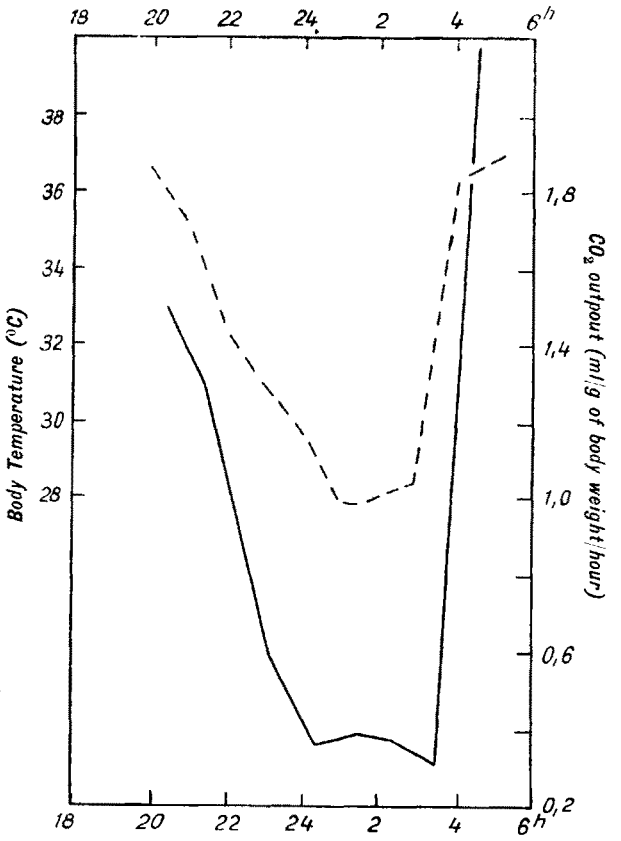

Fig. 4.

environmental temperature during the night drops noticeably. In consequence of this, a poikilothermic condition during the night is evidently very advantageous.

A temporary poikilothermy, appearing in a typical homoiothermic animal, is an interesting phenomenon of general physiology, worth especial attention. Appearing only in a state of a fairly long-developed hunger, it must, indeed, be regarded in certain respects as a pathological phenomenon. In spite of this, it evidently plays an important role in nature (compare KOSKIMIES[1]).

In birds, as far as is known, only humming birds (*Trochilidæ*) and some of their relatives (*Colias*) are able, under certain conditions, to fall into a coma (HUXLEY, WEBB, and BEST[2]). In this connection it is interesting to remember that the swifts are very closely related to the humming birds.—To what extent a corresponding poikilothermy appears also in other birds is not known. It should, however, be noticed that even the swift only falls into a hunger coma after a fairly long period of starvation. Thus, it is probable that in other birds, the hunger resistance of which is lower, the hunger coma may be very difficult to demonstrate experimentally.

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Zusammenfassung

Durch vollständiges Fasten können junge und erwachsene Mauersegler in eine Art von Erstarrungszustand versetzt werden. Hierbei sinkt ihre Körpertemperatur nach 24stündigem Schlaf beinahe bis auf die Temperatur der Umgebung). So wurde zum Beispiel am 7. Fasttag bei 19° C eine Körpertemperatur von 21° C gemessen. Während des Tages wurde die Temperatur wieder annähernd normal. Der Erstarrungszustand ist bei Jungtieren am deutlichsten. Bei den erwachsenen Mauerseglern gibt es Störungen der Temperaturregulation; der Tod tritt schneller ein als bei den jungen Individuen. Die Jungtiere können bedeutend länger fasten als die ausgewachsenen Mauersegler, da sie reichlich Reservestoffe besitzen (das durchschnittliche Gewicht der Jungen ist etwa siebenmal größer als das der Erwachsenen). Überdies ist der Stoffwechsel im Erstarrungszustand verlangsamt. In der Natur dürfte diese vom Verfasser festgestellte Hungerstarre während der Zeit des schlechten Wetters eine große Bedeutung besitzen, wenn die Mauersegler – und zwar vor allem ihre Jungen – kein Futter bekommen können.

[1] J. KOSKIMIES, Ornis Fennica, in press.

[2] J. S. HUXLEY, C. S. WEBB, and A. T. BEST, Nature *143*, 683 (1939).

Über induzierte Mutationserscheinungen an Milzbrand- und Kartoffelbazillen

Nachdem zuerst GRIFFITH[1] nachgewiesen hatte, daß unbekapselte Pneumokokken ein Kapselbildungsvermögen und damit eine Veränderung in ihren antigenen und pathogenen Eigenschaften erlangen können, wenn sie mit getöteten bekapselten Pneumokokken oder mit Extrakten aus solchen zusammengebracht werden, konnten AVERY und seine Mitarbeiter[2] eine Nukleinsäure als Erreger dieser Mutation bezeichnen. BOIVIN und seine Mitarbeiter[3] machten ebenfalls die Wirkung einer Nukleinsäure für die Umwandlung, die sie an *Bacterium coli* in der Richtung $R \rightarrow S$ beobachteten, verantwortlich. Wenn es in der Bakteriologie überhaupt statthaft ist, von Genen zu sprechen, so könnte man diese Versuchsergebnisse so interpretieren, daß sich durch die Aufnahme einer bestimmten Nukleinsäure aus einem Bakterienstamm derselben Bakterienart die Erbanlage der Bakterien um ein neues Gen (oder vielleicht sogar um mehrere Gene) vermehrt hat.

Wir stellten uns nun die Frage, ob es nicht gelingen könnte, auch bei unbekapselten Milzbrandbazillen (*Bacillus anthracis*) bzw. bei unbekapselten Kartoffelbazillen (*Bacillus mesentericus* [*vulgatus*]) das Entstehen kapseltragender Varianten zu erhalten, jedoch nicht durch Zellbestandteile («Gene») der homologen, sondern durch solche der fremden Bakterienart.

Zunächst wurden kapsellose Milzbrandbazillen (Abb. 1a) mit einem keimfrei filtrierten Auszug bekapselter Kartoffelbazillen im Mörser verrieben. Nach Aussaat solcher Gemische auf Agarplatten entstanden, im Gegensatz zu bekapselten Milzbrandbazillen, auch bei Züchtung in gewöhnlicher Atmosphäre, in mehreren Fällen neben einer überwiegenden Mehrzahl von typischen Kolonien der unbekapselten Milzbrandvariante auch schleimige Kolonien. Die schleimigen Kolonien, die entweder vollständig der Glattform des Kartoffelbazillus entsprachen oder von ihr nur insofern abwichen, als sie eine ganz homogene Beschaffenheit hatten (Abb. 1c und d), bestanden ausschließlich aus bekapselten Bazillen (Abb. 2a). Dabei erwiesen sich diese bekapselten Keime als ebenso begeißelt wie die Kartoffelbazillen (Abb. 2b).

[1] F. GRIFFITH, J. Hyg. *27*, 113 (1928).

[2] O. T. AVERY, J. exp. Med. *79*, 137 (1944); *83*, 89 (1946); *83*, 97 (1946).

[3] A. BOIVIN, Exper. *2*, 139 (1946).