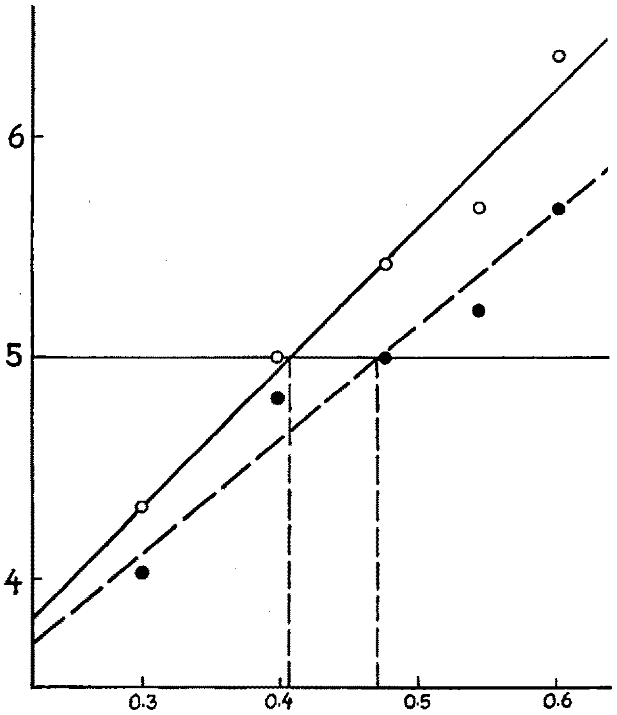
Es war daher geplant, die Regressionslinie für Chorion-Gonadotropin an männlichen Kröten zu berechnen und die mittlere wirksame Dosis (ED 50), das ist diejenige Dosis, bei der 50% der Versuchstiere positiv reagieren, zu bestimmen. Als Spezies wurde die Wechselkröte (*Bufo viridis*) gewählt, die sich in Versuchen mit Stutenserum-Gonadotropin bereits bewährt hatte[1]. Da BACH und SZMUK[2] an Fröschen gefunden hatten, daß beträchtliche jahreszeitliche Schwankungen in der Empfindlichkeit dieser Tiere gegenüber Gonadotropinen bestehen, wurden außerdem in der vorliegenden Arbeit die in den Monaten April und Mai erhaltenen Resultate miteinander verglichen.



Regressionslinien der Reaktion von *B. viridis* auf Chorion-Gonadotropin im April und Mai.

———o——— April; ———●——— Mai. (Jeder Punkt repräsentiert das Ergebnis an einer Gruppe von 12 Tieren.)

Abszisse: Logarithmen der Dosen in IE PU.
Ordinate: Wirkungsprozentsätze in Probits.

Die Ordinaten der Schnittpunkte der Regressionslinien mit der Abszisse entsprechend einem Probit von 5 ergeben die Logarithmen der mittleren wirksamen Dosen.

Zu den Versuchen wurde durchwegs das internationale Standardpräparat für Chorion-Gonadotropin (0,1 mg = 1 IE) verwendet. Als Lösungsmittel diente glasdestilliertes Wasser (20°C). Die Lösungen wurden so eingestellt, daß die jeweils gewünschte Dosis von Chorion-Gonadotropin (PU) in 1 ml Lösung enthalten war. Die Kröten (17–20 g Körpergewicht), deren Urin vor Versuchsbeginn auf Spermienfreiheit untersucht worden war, erhielten einheitlich 1 ml der Versuchslösung in den dorsalen Lymphsack injiziert. Drei Stunden nach der Injektion wurde der Kloakenharn neuerdings mikroskopisch auf Spermatozoen untersucht. Alle diejenigen Tiere wurden als positiv gewertet, in deren Urin Spermatozoen – gleichgültig in welcher Menge – gefunden wurden. Das Resultat wurde für die einzelnen Dosisgruppen als Verhältnis der positiven Tiere zur Gesamtzahl der Tiere in der jeweiligen Gruppe notiert und auf Grund dieser Daten die Regressionslinie von Wirkung auf Dosis errechnet.

Auf diese Weise wurden folgende Gleichungen der Regressionslinien für April und Mai erhalten:

$$\text{April} \quad E = 2{,}42 + 6{,}32\,X$$
$$\text{Mai} \quad E = 2{,}59 + 5{,}12\,X$$

Es bedeuten E = abhängige Variable (Wirkungsprozentsatz in *probits*[1]; X = unabhängige Variable (Logarithmus der Dosis in I E).

Daraus ergibt sich der Logarithmus der ED 50 für April (erhalten durch Gleichsetzen von $E = 5$) als 0,40611 mit einer *variance* $V = 0{,}00104$; das heißt, die ED 50 beträgt 2,55 I E PU mit den Grenzen 2,20–2,95 ($P = 0{,}05$). Die entsprechenden Werte für Mai sind: log ED 50 = 0,47085 ($V = 0{,}0016$) ∴ ED 50 = 2,96 I. E. PU, Grenzen 2,47–3,54 ($P = 0{,}05$).

Die Berechnung der relativen Empfindlichkeit April/Mai ergab das Verhältnis 1:0,85 mit den Grenzen ($P = 0{,}05$) 1:0,65 bis 1:1,10. Eine Abnahme der Empfindlichkeit im Mai gegenüber April erscheint statistisch nicht gesichert. Der χ^2-Test zeigte, daß eine signifikante Differenz weder zwischen den Neigungen der beiden Regressionslinien für April und Mai noch zwischen den beiden mittleren wirksamen Dosen besteht. Letzteres geht schon daraus hervor, daß sich die Grenzen der ED 50 für April und Mai (berechnet für eine Wahrscheinlichkeit von 95%) beträchtlich überschneiden.

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Physiologisches Institut der Universität und Physiologisches Institut der Tierärztlichen Hochschule Wien, den 17. September 1950.

Summary

To test the sensitivity of the male European toad *Bufo viridis* to chorionic gonadotrophin (PU) in two successive months (April and May), the regression of response (viz. the appearance of spermatozoa in the toads' urine) on dose was investigated. The median effective doses of PU were calculated from the regression lines. They were found to be 2·55 i. u. (April) and 2·96 i. u. (May) with the fiducial limits ($P = 0{\cdot}05$) of 2·20–2·95 and 2·47–3·54 respectively. Neither can any significance be attached to the difference between the ED 50 for April and May, nor did the slope of the corresponding two regression lines vary significantly. The relative sensitivity of the toads in May as compared with that in April was found to be 85%, with fiducial limits ($P = 0{\cdot}05$) of 65 to 110%. These findings indicate that no appreciable change occurred in the sensitivity of *B. viridis* to chorionic gonadotrophin during the period under investigation.

[1] R. A. FISHER und F. YATES, *Statistical Tables*, 3rd ed. (Oliver and Boyd Ltd., Edinburgh and London, 1948).

[1] F. X. WOHLZOGEN, Wiener tierärztl. Mschr. *37*, 394 (1950).
[2] I. BACH und I. SZMUK, Lancet *257*, 218 (1949).

Existence of True Males and Females in a Hermaphrodite Population of *Ophryotrocha puerilis*

The work of HARTMANN and his collaborators on sex reversal in the Polychaete worm *Ophryotrocha puerilis*[1] has raised a number of problems regarding sex determination and sex differentiation in hermaphrodite animals. In the case of *Ophryotrocha* HARTMANN's results

[1] M. HARTMANN et al., Zool. Jahrb. *56*, 389 (1936); *58*, 551 (1938); *60*, 1 (1940).

may be summarized as follows: (a) all individuals change sex from male to female phase at lengths ranging from 15 to 20 chaetigerous segments; (b) reversal from female to male phase can be produced experimentally by amputation leaving 5–10 segments, by starvation, by raising the K ion concentration, or by the action of ripe egg extracts. On the basis of these results HARTMANN[1] has concluded that age determines sexual constitution, youth favouring the male and age the female phase, the sex determination not being genetical.

It is difficult in my opinion to reconcile the existence of a given trend in the succession of sexual phases with the assumption of a purely phenotypical sex determination. As far as external factors are concerned, we must remember that, even in animals where genetical determination is a well established fact, sex inversions have been obtained by means comparable to those mentioned above. It is common knowledge that, if we remove the ovary from a hen, the right gonad hypertrophies and differentiates as a testis: CHAMPY[2] showed that even functional sperms can be produced in this organ, a result comparable to that found in *Ophryotrocha*. Sex reversal under the action of egg extracts may also be put into relation with the results of PADOA[3] who showed that female hormones in high concentration produce complete masculinisation of Amphibians. In general, the evident low specificity of many sexual factors in species where sex is demonstrably determined genetically forbids us at present to exclude a genetical component in the sex determination of *O. puerilis*.

It must be pointed out that HARTMANN's experiments have been made with little reference to sexual conditions in nature. In a species where sex reversal is a normal occurence, the succession of sexual phases under normal environmental conditions also requires to be considered carefully. Recent researches have demonstrated that hermaphroditism must be studied in large samples of a population[4].

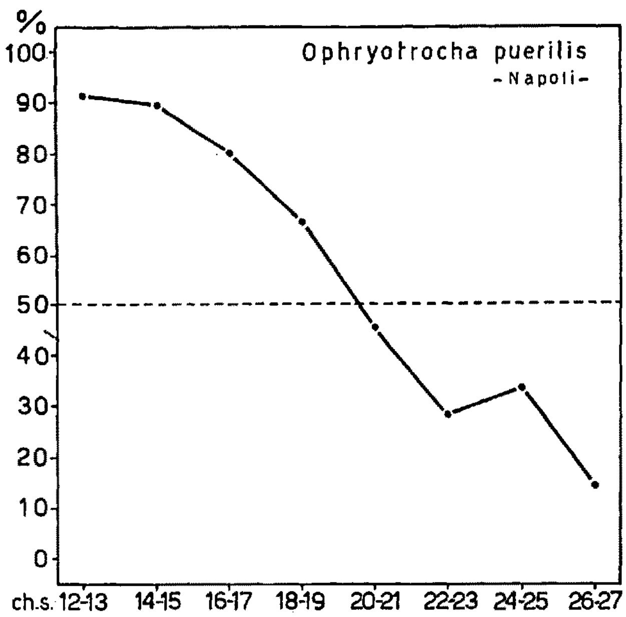
The present study has mostly been carried out on animals collected during the month of April in the harbour of S. Lucia in the Bay of Naples. Functional male and female phases are easily distinguishable in healthy specimens. It is therefore possible to estimate in *Ophryotrocha* the different proportions of individuals in the male and female phase at different ages and consequently the periods when changes of sex take place in the different individuals. For this purpose a method previously used by the author has been employed: if we plot the number of individuals in the male phase against the total number of individuals in each size class, we obtain a curve such as that shown in the figure: the abscissa represents the number of chaetigerous segments, the ordinate the percentage of individuals in the male phase. This curve, based on the examination of 526 specimens shows that:

(a) sex inversion may occur at any size class;

(b) there is a small percentage of females among the individuals of the lower size classes, a small percentage of males in the higher size classes. Ripe females with 11 and males with 32 chaetigerous segments were also observed among individuals collected in S. Lucia or from tanks within the Aquarium.

[1] M. HARTMANN, *Die Sexualität* (Fischer, Jena 1943).
[2] C. CHAMPY, C. R. Acad. Sci. Paris *209*, 904 (1939).
[3] E. PADOA, Monit. Zool. Ital. *47*, 285 (1936); Pubb. Staz. Zool. Napoli *19*, 185 (1943).
[4] G. BACCI, Pubb. Staz. Zool. Napoli *21*, 183 (1947); ibid. *22*, 1 (1949); Arch. Zool. Ital. *34*, 49 (1949); Exper. *7*, 31 (1951).

It would appear that previous authors[1] have either overlooked large size males and small size females or that they have studied the succession of sexual phases in a different sexual race of *O. puerilis*. It is now important to establish whether phenomena of alternative sexuality have any importance in the statistical composition of the population.



Animals were isolated and kept in Boveri dishes containing 10 cm^3 of Erd Schreiber to which were added every 5 days 2 cm^3 of a flourishing culture of *Chlamydomonas*, a corresponding quantity of liquid being removed from each dish. Exposition to light permitted the growth of *Chlamydomonas* in the Boveri dishes and, in order to maintain conditions as far as possible identical for this factor, the position of the dishes was interchanged whenever food was added. Food appeared to be superabundant at each inspection of dishes containing both large and small individuals.

8 ripe females measuring 11–12 chaetigerous segments were kept under these conditions, and at the end of four months they reached the size of 28–30 chaetigerous segments, always remaining in the female phase. One female only laid eggs (which were probably self-fertilized) at the length of 16 chaetigerous segments and again showed eggs three days subsequently, always remaining in the female phase. Individuals in the female phase of higher size classes always remained females, when kept isolated, with the exception of short periods of 5–10 days when they laid eggs and passed through a transitory male phase. It should be added that transitory male phases are more frequent in young individuals.

Out of 45 male phase individuals collected at lengths below 20 chaetigerous segments, only one remained male up to the size of 29 chaetigerous segments, when it was used for other experiments; a further two became females at the length of 26–27 segments, the others at different lengths below 25. Out of 6 male phase individuals taken from S. Lucia of initial sizes ranging from 27 to 32 segments, one individual measuring 27 chaetiger-

[1] E. KORSCHELT, Zeit. wiss. Zool. *57*, 272 (1893). – W. HUTH, Z. Zellf. mikr. Anat. *20*, 309 (1933). – M. HARTMANN *et al.*, Zool. Jahrb. *56*, 389 (1936); *58*, 551 (1938); *60*, 1 (1940).

ous segments became female when it reached 29 chaetigerous segments, another, at the size of 30 chaetigerous segments, developed medium size oocytes which lasted 3–4 days and then disappeared, the animal having reached the size of 31 segments when it died. The other individuals always remained in the male phase for periods varying from two to four months, when they were used for different experiments.

The statistical analysis of the population and the cultivation of isolated individuals in uniform conditions thus indicate the existence of intrinsic differences in the sexual differentiation of various individuals of the population. We will see in a following note how these intrinsic differences can account for different reactions toward the same sex changing factors.

Although there is in the Naples *Ophryotrocha* a tendency toward protandry and toward reversal to female phase, some individuals remain always males, some females. They can be called *true or primary males* and *females* (BACCI[1]). Some *Ophryotrocha* on the other hand become females at an old age, some at a medium, some at an early age. Sex conditions show the character of *continuous variation*. The author demonstrated similar facts in the Gastropod *Patella coerulea* and showed their close resemblance to phenomena previously observed in *Bonellia* and *Crepidula*, which must be considered *unbalanced hermaphrodites* (BACCI[1]). It would be wrong to infer from statistical observations or physiological experiments alone the type of sex determination in an animal. Breeding experiments will be needed to test the validity or otherwise of the hypothesis put forward jointly by G. MONTALENTI and the writer, which attempts to explain the different expressions of sexuality of these animals as resulting from the segregation of multiple genes[1].

GUIDO BACCI

Zoological Station of Naples, October 2, 1950.

Zusammenfassung

Es wird mit statistischen und Zuchtmethoden bewiesen, daß bei *Ophryotrocha puerilis* in Neapel die meisten Individuen auf verschiedenen Altersstufen einen Geschlechtsumschlag zeigen, während einige Exemplare stets männlich oder stets weiblich bleiben (wahre oder primäre Männchen und Weibchen). Diese Geschlechtsformen bilden also eine ununterbrochene Variationsreihe, welche möglicherweise durch die Spaltung von multiplen Sexualgenen verursacht wird.

[1] G. BACCI, Pubb. Staz. Zool. Napoli *21*, 183 (1947); ibid. *22*, 1 (1949); Arch. Zool. Ital. *34*, 49 (1949); Exper. *7*, 31 (1951).

Handedness in Monkeys

In 1949, GRÜNTHAL[1] published an interesting paper on the significance of a dominant hemisphere in man, in which he discusses the phenomenon of handedness. We find in this paper the remark that in apes and monkeys no preference for one hand is shown.

In 1876, FERRIER[2], a brilliant observer of detail, studying the function of the brain and using for his experiments monkeys, noticed and recorded in the case of a rhesus monkey that it, "was found to be, as a rule, left-handed, taking things offered to it preferably with the left hand".

[1] E. GRÜNTHAL, Dtsch. med. Wschr. *74*, 943 (1949).
[2] D. FERRIER, *The Function of the Brain* (Smith, Elder & Co., London, 1876).

No one seems to have paid any attention to this chance observation, and very few people to-day know whether or not apes and monkeys in common with man have a dominant hand.

However, this point interested FINCH[1] in America in 1941 and he investigated what he calls "handedness" in thirty chimpanzees by training them to pull a string and use other apparatus, and so obtain food. Each animal was given 800 trials and a careful record was kept of the hand used.

He found that of the 30 subjects 25 showed a marked preference for one or the other hand; 18 used the same hand, 9 the left and 9 the right, in over 90% of the trials. Of the total number, those with the right or left hand dominant were almost equal.

Another fact which emerges from his experiment is that the degree of dominance varies from the 90% mentioned, down to the 5 cases where no clear preference for either hand could be detected.

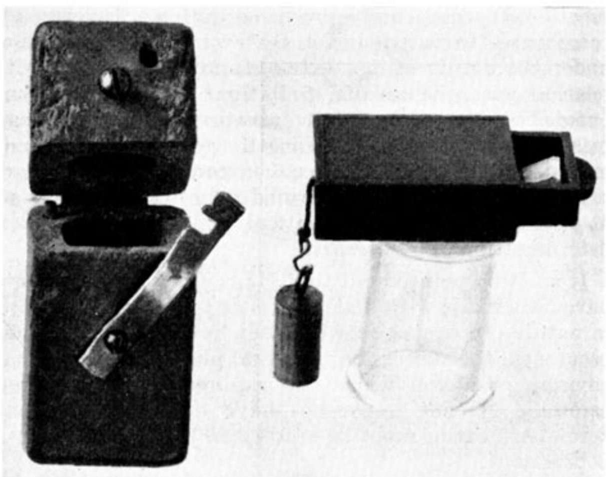


Fig. 1. – Problem box and match box drawer used in our tests.

Two years later YERKES[2], also studying chimpanzees, was able to confirm the findings of FINCH, obtaining similar results which are recorded in his book on these animals.

Chimpanzees are of course high in the evolutionary scale, being classified as apes, so the question of the "handedness" of those a little lower down (i.e. monkeys) now arises.

Like FERRIER, we have used monkeys in our studies of brain functions, (GLEES and COLE[3]), and we have observed that not only one genus, but all the three which we have used, have a dominant hand[4]. It is difficult if not impossible to detect this merely by observing the animal climbing about its cage and eating its food, nor is it a reliable guide to observe which hand is used to take offered food, except in the case of animals with a very complete dominance of one hand. If we are to say with certainty which hand is dominant in a particular animal, it is essential that it should be trained to perform skilled acts.

For this purpose we used two pieces of apparatus, our problem box and our match box drawer (fig. 1). To

[1] G. FINCH, Science *94*, 117 (1941).
[2] R. M. YERKES, *Chimpanzees* (Yale Univ. Press, 1943).
[3] P. GLEES and J. COLE, Verh. dtsch. Zool. Mainz, 198 (1949); J. Neurophysiol. *13*, 137 (1950).
[4] P. GLEES, J. COLE, E. G. T. LIDDELL, and C. G. PHILLIPS, Arch. f. Psychiat. u. Zschr. Neurol. *185*, 675 (1950).