Moreover, Jensen and Asmussen's supposition demands a resonance between two valency states (formally II and IV). Now numerous complexes of this type are known and, as these authors point out elsewhere in the same paper, the resonance is associated with intense colour. But the colour of iron enneacarbonyl is only orange-yellow, and the cobalt carbonyl $Co_2(CO)_8$, the formulation of which entails the same difficulty, is but a pale yellow, so that this evidence certainly offers no support for Jensen and Asmussen's view.

It would, however, be very curious if this rare type of metal–metal linkage were confined to iron enneacarbonyl; but it appears certain that other examples exist. Thus the dimeric and diamagnetic cobalt tetracarbonyl $Co_2(CO)_8$ can be formulated as in Fig. 7,

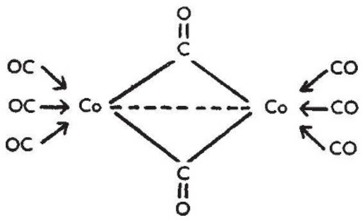

Fig. 7

in which the cobalt, initially with one electron more than iron, requires one carbonyl bridge less to become isoelectronic (effective atomic number 36) with the metal atom in the diamagnetic $K_3[Co(CN)_6]$ and the diamagnetic iron compounds above.

'Roussin's red salt' and its analogues form an even more interesting group of compounds, the structures of which may be explained in a similar manner. These compounds are all of the type $Fe(NO)_2X$, where X may be $—S^-K^+$ (the original red salt), —Cl[4], —I[5], $—S.C_2H_5$, $—S.C_6H_5$, or $—S.SO_3^-K^+$ (the thiosulphate). Of these the chloride and the ethyl and phenyl esters have been shown to be dimeric, while Roussin's red salt itself[6] and the thiosulphate[7] have been shown to be diamagnetic, so that we may fairly assume the degree of polymerization and the magnetic behaviour to be the same for all these substances. They may then be assigned the general structure shown in Fig. 8, in which each nitrosyl

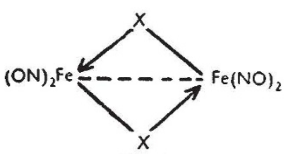

Fig. 8

group contributes three electrons to the metal atom (as in $\overset{=}{M} - \overset{+}{N} \equiv \overset{+}{O} \sim \overset{+}{M} = \overset{-}{N} = O$[8]). In addition, each iron atom acquires three electrons from the bridging groups and one from the Fe–Fe link, giving $26 + 2 \times 3 + 3 + 1 = 36$ as the effective atomic number.

An earlier view, that these compounds are really hyponitrites, has been criticized by Manchot[9], and is rendered the more unlikely by the observations that iron dinitrosyl dicarbonyl $Fe(NO)_2(CO)_2$, in which the NO groups are distinct[8], reacts smoothly with iodine[5] and with benzenethiol[10] to give the corresponding Roussin-type compounds. This being so, the above bridged structure is the only plausible alternative, and the Fe–Fe link is then necessary to explain the diamagnetism.

Even the more complicated Roussin's black salt $K[Fe_4(NO)_7S_3]$ can be explained on similar lines. A fuller account of this and other matters related to the above discussion will be published elsewhere in due course.

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CHROMOSOMAL EVOLUTION IN THE EUROPEAN MOLE-CRICKET

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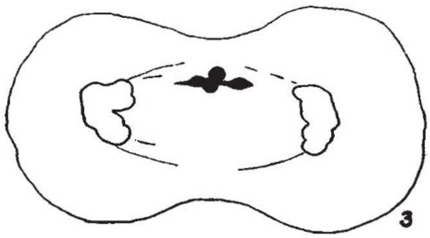
It is well known that species belonging to the same genus frequently differ in their chromosomal numbers. Special interest is attached to this diversity, since it may furnish a clue to the mode of evolution of the species. Although reduction in number of chromosomes appears to occur fairly frequently, practically nothing is known about their increase in numbers except by polyploidy, which occurs very rarely in animals. The European mole-cricket (*Gryllotalpa gryllotalpa* L.) is a most interesting example of a progressive increase in chromosome number within the limits of the same species. It would appear that speciation based on diversification of chromosome numbers is here at work.

The species *G. gryllotalpa* may be divided into four geographical races which differ in their chromosomal numbers. The northern race found in Belgium, Germany, France and northern Italy has 12 chromosomes (10 autosomes and XY)[1,2]. In Roumania there is a second race with 14 chromosomes (12 autosomes and XY)[3]. A third race in central Italy is characterized by 15 chromosomes in the male (14 autosomes and X)[4], while a type with 17 chromosomes was observed in southern Italy[5]; the same type has recently been found by Barigozzi[6].

Barigozzi[7] and de Winiwarter[2] suggested that fragmentation of two pairs of anisobrachial metacentric chromosomes of the northern race may have given rise to the two additional small pairs characteristic of the central Italian type. This hypothesis is certainly much too simple, as it is well known that acentric fragments are non-viable. White[8], on the other hand, postulated that evolution occurred by reduction of the number of chromosomes, since two species of *Gryllotalpa*, namely, *G. borealis* and *G. africana* and a related genus *Scapteriscus*, have 23 chromosomes (22 autosomes and X).

In a cytological study of the Palestinian mole-cricket, which belongs to *G. gryllotalpa*, we observed two new races, one with 19 chromosomes (18 autosomes and X, Fig. 1), and the second with 23 (22 autosomes and X, Fig. 2). The first (19 chromosomes) is common throughout Palestine (Judean Hills, the coastal plain, Valley of Esdraelon, Beisan





Figs. 1 and 2. SPERMATOGONIAL METAPHASE OF MOLE-CRICKET: (1) PALESTINIAN RACE, 19 CHROMOSOMES; (2) DEAD SEA RACE, 23 CHROMOSOMES; FROM PREPARATIONS FIXED IN 15 PARTS PICRIC ACID, 5 PARTS FORMALIN, 1 PART 45 PER CENT ACETIC ACID

Fig. 3. TELOPHASE OF MEIOTIC DIVISION, AN OCTAD LAGGING IN EQUATORIAL PLANE, PREPARATION FIXED IN BOUIN'S SOLUTION. ALL SECTIONS 10 μ THICK, STAINED IN HEIDENHAIN'S HÆMATOXYLIN. × 2100

Valley and Galilee), while the second (23 chromosomes) is restricted to a single locality very close to the Dead Sea.

All the elements of the Palestinian race seem to be homologous with those of the central Italian race, except that six small chromosomes occur instead of only two of the same size which are found in the Italian type. In the Dead Sea race there are ten such small chromosomes. In the light of these facts, it was difficult to assume that the direction of evolution was towards reduction, as all the remaining elements appear identical in the three races, a fact which argues against the possibility of translocation. On the other hand, it is also difficult to assume that eight elements would disappear from the chromosome pattern, leading from the Dead Sea type to that of central Italy.

The behaviour of these chromosomes at meiosis was found to be peculiar. In approximately 13 per cent of the observed cases, certain chromosomes lag in the anaphase and telophase. These chromosomes, which can be identified as the small ones, remain as tetrads in the equatorial plane during the anaphase movement of the other dyads. Sometimes plates with octads are seen, linked by means of chiasmata (Fig. 3), a fact which clearly demonstrates the common origin of these small chromosomes. In most of these cases the normal separation of the dyads finally occurs, the dyads joining the nuclei almost at the termination of telophase. But in a considerable percentage of cases a whole tetrad passes to one daughter nucleus, and sometimes even an octad passes to one pole. As a result of this non-disjunction, among second spermatocytes there are cells containing eleven dyads as well as others containing only seven. Since spermatids with varying numbers of chromosomes are formed, one might expect to find mole-crickets with varying numbers of chromosomes, 17, 18, and 21. Examination of 140 mole-crickets from six localities in Palestine has shown that 19 is the only chromosomal number found. Hence it may be concluded that the exceptional gametes or the new types emerging from them are non-viable at some stage in development.

The six small chromosomes show no heteropycnosis at the meiotic prophase, whereas the two small chromosomes in the Italian race exhibit a typical heteropycnosis during meiosis, and become precociously condensed at prophase together with the X-element. In the light of this evidence, it is difficult not to conclude that we are dealing with the establishment of permanent from supernumerary chromosomes, in other words, a transition from hetero- to euchromatin. While the transformation of euchromatin to heterochromatin by mutation of active genes to inert ones is more frequently postulated by geneticists, the reversion of this process appears equally plausible.

It may be significant that heterochromatic chromosomes are still present in the Roumanian race and that they behave as typical supernumeraries, that is, their number in the population fluctuates. Thus mole-crickets with 15 or 16 chromosomes are found in addition to the common type with 14 elements[3]. In size and form the additional chromosomes correspond to those described in the Palestinian material. Supernumerary chromosomes of a similar type were also found in *G. africana*[4].

Due to their inertness, supernumerary chromosomes may increase in number in some individuals without causing conspicuous damage. On the other hand, Darlington claimed that in some cases (*Zea Mays*, *Cimex*, etc.) they possess adaptive advantages[9,10]. It may be that a further step involving a certain number of new viable mutations establishes them in certain types.

In this connexion it is interesting to note that the highest chromosome number among the Palestinian mole-crickets (23) is found in the Dead Sea locality, where temperature fluctuation and salinity of soil are extreme. It is an almost inevitable conclusion that the two additional pairs of small chromosomes contain a set of polygenes which enable this race to survive under extreme conditions.

The chromosomes of *G. africana* (23) from the southern Dead Sea fully conform to the description of previous authors[4]. They differ fundamentally from the 23 chromosomes of the Dead Sea race of *G. gryllotalpa*. The 23 chromosomes of *G. africana* can be arranged in a series of fours, which makes it probable that the species is a tetraploid.

Thus the number 24 (in the female) was reached twice by independent methods in the mole-crickets. Whereas in *G. africana* (and probably *G. borealis* and *Scapteriscus*) 24 were obtained by doubling of the original set of 12, in *G. gryllotalpa* a progressive accumulation of small (heterochromatic) chromosomes led to the establishment of a whole series of geographical races and found its climax in the Dead Sea race with the same number, 24. A fuller discussion of this problem and of the origin and behaviour of the small chromosomes will be published elsewhere.

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