After which, at the approach of the dry season, and the discontinuance of the camp early in May the numbers gradually lessened.

So far as the incidental appearance of malaria is concerned, while Major Ashburn says the reports are perhaps unduly favorable, the first case was sent into hospital February 7. In December, shortly after the opening of the camp it was inspected and malaria was predicted, but was not then present; in February two cases were reported, by the last of March the percentage on blood examination had risen to 20 per cent., and in April to 100 per cent.

It is to be noted that these *Anophelines* "did not greatly abound until after the laborers had been at this location for three weeks or more, and malaria made no headway until after two months."

From these observations Major Ashburn concludes, although for very different reasons than the usual ones of ability in length of flight, that "in ordinary sanitary practise, and not considering such exceptionally large and favorable breeding places, the control of all breeding within four hundred yards of towns, posts and houses serves to make them fairly comfortable and safe residences."[3]

It is however the difference in reasons that makes Major Ashburn's conclusions of especial value, and the whole of Major Ashburn's paper is well worth study. It throws an absolutely new light on the subject, gives a valid reason for the acknowledged limit of four hundred yards as the usual flight of *Anopheles,* and clears up some points in mosquito control that have hitherto been obscure and bewildering.

C. S. LUDLOW

ARMY MEDICAL MUSEUM,
WASHINGTON, D. C.,
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[3] Ashburn, P. M., "Elements of Military Hygiene," 2d ed. (1915).

SPECIAL ARTICLES

THE ORIGIN BY MUTATION OF THE ENDEMIC PLANTS OF CEYLON

IN a recent paper Dr. J. C. Willis has made a statistical study of the flora of Ceylon in order to show that the indigenous species of this island must have been developed by mutation and without any kind of advantageous response to local conditions.[1]

It is obvious that the mutation theory wants in the first place a study of those facts which may throw a direct light on the evolution of wild species and that only relatively young forms have a sufficient chance of still living under the same or almost the same conditions, under which they originated. The material, afforded by the flora of Ceylon, is exceptionally rich in this respect and thoroughly well prepared by numerous investigators and especially in the great "Flora of Ceylon" by Trimen and Hooker.

Ceylon is a comparatively small island (25,000 sq. miles) and has a flora of 2,809 species of Angiosperms, of which 809 are endemic to the island.

Moreover of the 1,027 genera to which those species belong, 23 are confined to Ceylon, and among the 149 families, this is the case with six. Among the endemic genera 17 are represented by one species only, four by 2–3 and only two by a large number. These latter are *Doona* with 11 and *Stemonoporus* with 15 species, almost all of which are very rare forms, but distinguished from one another by characters of full specific rank. They give the impression that they may have been formed by what *Standfuss* has called explosive methods, a number of new species being produced almost at the same time.

As a rule, the endemic species are rare or very rare. More than a hundred of them are confined to one mountain top or to some very small area in the mountains.

Many of these occur as a very few individuals, say a dozen or little more, and the places where they can thrive are so small that it is obvious that they can never have been much more numerous. They must have evolved on the spot where they are found. Notwithstanding this, they are well-marked Linnean species and accepted as such by Trimen and Hooker. Not rarely their distinguishing characters are relatively large.

[1] J. C. Willis, "The Endemic Flora of Ceylon, with Reference to Geographical Distribution and Evolution in General," *Phil. Trans. Roy. Soc. London,* Series *B,* Vol. 206, pp. 307–342.

In drawing such conclusions, however, even from a thorough knowledge of a flora, one is often exposed to lay too much stress on striking but exceptional instances, whereas it is only averages which may really be relied upon. For this reason Willis has worked out a method, which gives a large degree of accuracy and thereby affords a firm and unattackable basis for his deductions. Trimen divides all species into six classes: Very Common, Common, Rather Common, Rather Rare, Rare and Very Rare, and his estimates are thoroughly reliable, as is shown by the clearness and regularity of the results derived from them.

In order to compare two or more groups of species Willis multiplies the number of species in them, belonging to each of these classes by a factor indicating the degree of rarity according to the estimates of Trimen. These factors are 1 for very common, 2 for common and so on, up to 6 for very rare. In this way averages may be calculated, which give the relative degree of rarity for any group under consideration.

Next, the plants of Ceylon are divided into three main groups, one containing the endemic species, the second those confined to Ceylon and Peninsular India, and the third the forms of wider (although often not very much wider) distribution. In this way Willis finds:

	No. of Species	Rarity
Mean rarity of all species ..	2,809	3, 5
Species of wide distribution.	1,508	3, 0
Of Ceylon and Peninsular India	492	3, 5
Species endemic to Ceylon...	809	4, 3
Species of all 23 endemic genera	52	4, 5
Species of *Doona* (endemic)..	11	4, 6
Species of *Stemonoporus* (endemic)	15	5, 4

Thus the species of wide distribution are the commonest, those of Ceylon and India have just the mean degree of rarity, but the endemics are relatively rare, the rarest of all being the species of the endemic genera and especially those of the only two genera which are rich in endemics. Results of the same kind, obtained by applying this method to different manners of bringing the species of this island into groups, are given in numerous tables, the study of which will be of great importance to all scientists interested in the subject.

One of the main results is that the variation in rarity between the different families or groups of families of Ceylon-endemics is small, and goes to show that no one family has any particular advantage over another. In comparing the genera with one another the same rule prevails, independent of the question which genera are chosen and from which point of view the comparison is made.

The order of rarity: Ceylon, Ceylon and Peninsular India, Wider Dispersal, holds throughout all comparisons with extraordinary regularity. It is obvious that some general law must be underlying these phenomena.

If the endemic species had originated by natural selection of infinitesimal steps and in response to the local conditions, which are obviously the only conditions that matter when the species first appears, they must have been, from this very origin, better adapted to these conditions than their parent species. According to the theory of natural selection it would follow that they must surpass their forerunners in the struggle for life and soon spread to a higher degree of commonness. But as the table shows, the reverse is true. Yet they have had ample time even for gaining a comparatively wide dispersal. Several recently introduced species have spread to the stage of very common, often in a few years. *Tithonia diversifolia,* one of the Compositæ, began to spread about 1866 and in 1900 was all over the island in damp enough spots. *Mikania scandens* began to spread ten years ago and is already common all around Peradeniya. Many other instances could be given, since about 60 introduced species have become more or less common in the island.

Of the 809 endemics of Ceylon only 90 are now common and only 19 very common in the island, the remainder are mostly rare or very rare. If they did not conquer their parents and spread into larger areas, it is obvious that they were not especially adapted to the conditions prevailing in the island, and at least not better adapted than the species from which they sprung. Or, in other words, that they did not originate in advantageous response to those local conditions. A large amount of facts and considerations has been brought forward by the author in order to justify this conclusion.

These conclusions provide us with a strong argument against the hypothesis of a slow and gradual evolution by small and almost invisible steps, and for the theory of their production by mutations. In the rare cases of rapid dispersal of new species a better adaptation may of course be assumed as one of the chief factors, but on the average the dispersal is very slow in the beginning, giving no argument in favor of this view.

Furthermore these considerations lead to the view that wide distribution and commonness are chiefly dependent on age, and only rarely on adaptation. In every family the genera with the widest distribution may be considered as the oldest, those with a smaller domain as younger, and the local endemics as the youngest of all. These principles will be used in subsequent studies to draw pedigrees of families. But the studies made by the author up to this time go to show that nearly all families have the same general type of distribution, that evolution of forms is on the average indifferent, and that most of the so-called adaptations are of no special advantage to their possessors.

Another argument relates to the possible size of mutations. It is often assumed that mutations must of necessity be small, considering that it seems probable that only one unit-factor will be changed at a time. This conception seems to the author to be an unnecessary handicap to the theory of mutation and he proposes that it should be replaced by the hypothesis that no specific change is too great to appear in one mutation. The difference between endemic species of Ceylon and their nearest allies is often very large, as may be deduced from the fact that they are accepted as well-marked Linnean species by such authorities as Trimen and Hooker. But in many cases they are even larger. For instance, *Coleus elongatus,* which occurs only on the top of Ritigala and here only in about a dozen of individuals, differs so much from all other *Colei,* that it may well be regarded as subgenerically distinct. And for the 17 endemic genera, which have only one species each, it seems at least very probable that the whole genus has arisen at a single step.

In concluding I might state that my own studies on the production of new forms among the Œnotheras have of late led me to the conclusion that mutations are in many cases of a far more complicated nature than has been assumed until now. Many of them, as for instance the production of *O. rubrinervis, O. nanella* and *O. gigas,* involve the simultaneous change of two or more characters, in some cases of quite a large number of unit-factors. Why these changes should so regularly go together, we do not, as yet, know, but the fact goes to increase the analogy between the experimental mutations of these plants and the mutations in the wild condition of the Ceylon endemics.

From the facts adduced by Willis, and reviewed in this article, it seems obvious that the parallelism of natural and experimental mutations is a very close one.

HUGO DE VRIES

ELECTRICAL DISCHARGE BETWEEN CONCENTRIC CYLINDRICAL ELECTRODES

IN operating vacuum tubes we invariably use an induction coil or an electrostatic machine. The discharge in either case is never quite steady and hence these methods of operation do not lend themselves well to a critical study of the growth of the cathode dark spaces. A steady, and of course continuous, discharge may be had if the current is drawn from a high potential storage battery. Ordinarily it takes more cells than are available; however, by a right choice of conditions a rather extended study may be made with direct current potentials of less than 1,000 volts. The following experiments with concentric cylindrical electrodes were performed recently by the writer in class demonstration.

The discharge vessel consists of an ordinary