increases exponentially throughout the germination stage; (4) in the cotyledon, the amounts of P.N.A.-P, dry weight, and protein-N simultaneously decrease rapidly with the elapse of time. It is worth while to point out that a large amount of P.N.A.-P is found in this *reserve organ* at the initial stage of germination.

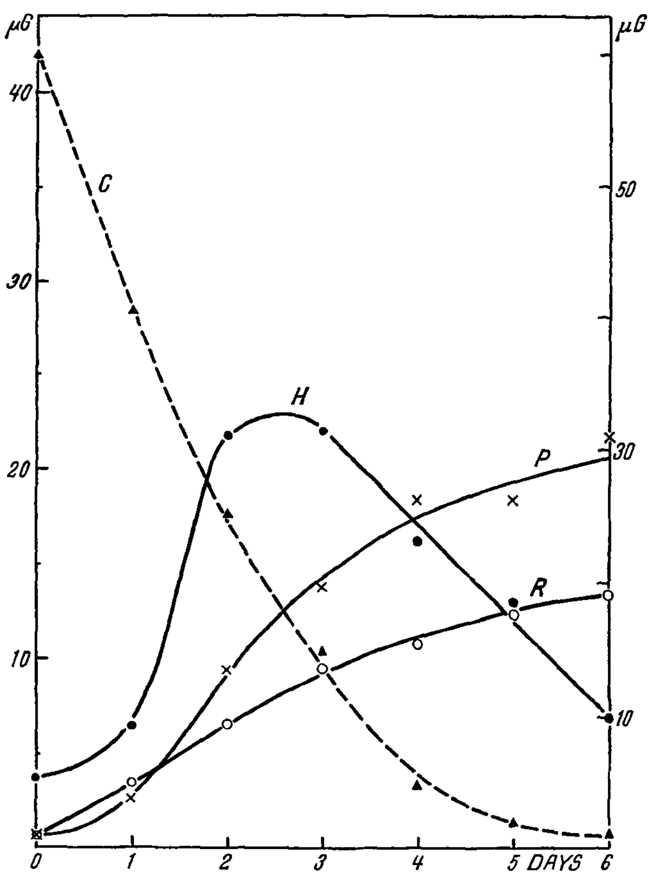

Fig. 3.—Changes in pentose nucleic acid phosphorus content of embryonic organs of *Vigna sesquipedalis* during the germination stage. See text of Figure 1 for symbols used. Scale in the right ordinate, for Cotyledon; the left, for *P*, *H*, and *R*.

Close parallelism between increase of P.N.A. and that of protein is thus demonstrated in all anabolic (growing) organs studied. This is most strikingly recognizable in the hypocotyl tissue in which the mode of growth is shown to change categorically from "division" to "elongation" at about the middle of the germination stage[1]. Increase of protein occurs only in the earlier half of the germination stage, while in the later half protein content remains practically constant; P.N.A. increase is observed only in the earlier half, and it begins to disappear as the protein increase ceases. The result seems to suggest that if P.N.A. is indeed involved in protein synthesis, then a synthesis rather than only existence or degradation of P.N.A. may be significant for the formation of protein. This view is thought to be supported by the several similar findings in animal and microbial materials[2]. In this connection, it is also a noticeable fact that in all the embryonic tissues except cotyledon, an approximately constant quantitative relationship between maximum contents of both protein-N and P.N.A.-P (*ca.* 14:1) was observed.

As for the unexpectedly high P.N.A. content of the cotyledon, the possible existence of reserve phosphates such as phytic acid, which, if present, would be removed by the cold trichloroacetic acid treatment in our fractionation procedure, may not be the cause of such high phosphorus value observed for the P.N.A. fraction. In the germination stage, the cotyledon tissue which is now catabolic in nature is practically deprived of any ability to produce P.N.A. Hence the existing P.N.A. would be the survival of what had been produced in the anabolic phase of the cotyledon in its earlier stage of development on the placenta. We believe that this is the first case in which a reserve organ is found to have such a large amount of P.N.A. even in its mature stage. The significance of this high P.N.A. content in the cotyledon is as yet obscure

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Zusammenfassung

In den embryonalen Geweben einer Hülsenpflanze, *Vigna sesquipedalis*, findet Zunahme an Proteingehalt stets zugleich mit Zunahme an Pentosenukleinsäuregehalt statt. Dies ist ein genau gleiches Verhalten, wie man ihm bereits bei Mikroben sowie bei tierischen Geweben begegnete. In den Kotyledonen (Reserveorgane) wird ein unerwartet hoher Gehalt an P.N.A. gefunden.

Colour Pattern and the Definition of the Species, *Diadema antillarum* Philippi

Six species have been distinguished in the echinoid genus *Diadema* (Humphreys, 1797) Gray[1]. Distinctions are maintained on the grounds of differences in the shape of the valves of the tridentate pedicellariae, the number of series of large tubercles in the interambulacral areas of the test and the colour pattern.

MORTENSEN[2] long ago urged that more attention should be directed to these colour differences, which mainly concern the disposition of blue areas on the black background of the test, on the grounds that herein may exist a clue to the interrelationships of the several species. Thus it is stated that the blue pattern of the genotype *D. setosum* (Leske) is very characteristic, consisting of isolated spots, whereas that of *D. antillarum* Philippi forms continuous lines, in the interambulacra. In *Diadema Savignyi* (Audouin) Michelin, a continuous blue ring around the periproct is described, which is stated to be absent in *D. antillarum*, etc.[3].

My own studies on the last form have shown that the distribution of the blue colour has been inadequately described and although I have not yet had the opportunity of examining any other species, in the case of

[1] Y. OOTA, Science (Kagaku), Tokyo *23*, 60 (1953); Embryologia, Nagoya (in press).

[2] S. OSAWA and Y. HAYASHI, Science (Kagaku), Tokyo *23*, 34 (1953). – M. FUKUDA and A. SIBATANI, J. Biochem., Tokyo (in press). – S. OSAWA (unpublished experiment). – W. H. PRICE, J. gen. Physiol. *35*, 741 (1952).

[1] TH. MORTENSEN, *A Monograph of the Echinoidea* (Reitzel, Copenhagen, 1940), p. 111.

[2] TH. MORTENSEN, U. S. Nat. Mus. Bull. Washington *74* (1910).

[3] TH. MORTENSEN, *A Monograph of the Echinoidea* (Reitzel, Copenhagen, 1940), p. 111; U. S. Nat. Mus. Bull. Washington *74* (1910).

D. antillarum, the distinctions drawn on the basis of the blue pattern are certainly not so well defined as previously maintained. Thus there are well marked colour changes[1], both physiological and morphological, which affect precisely those blue areas that have been accorded systematic significance.

Figs. 1 and 2.—Two views of *D. antillarum* showing the colourpattern which develops on the test in darkness.

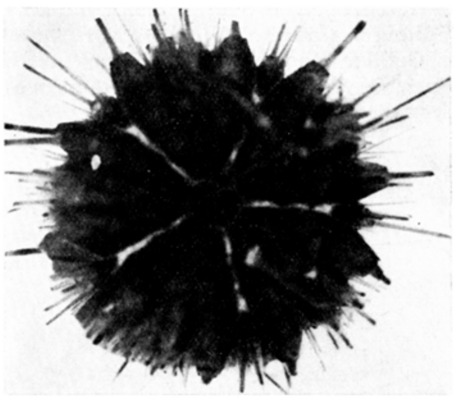

Fig. 1.—Aboral view of a young form photographed after being in total darkness for 3 h. The spines have been cut short. 2:1. Note that the pattern includes a ring around the periproct and that the ray-like portions of the pattern in the interambulacra are becoming obscured in parts by the spreading of pigment.

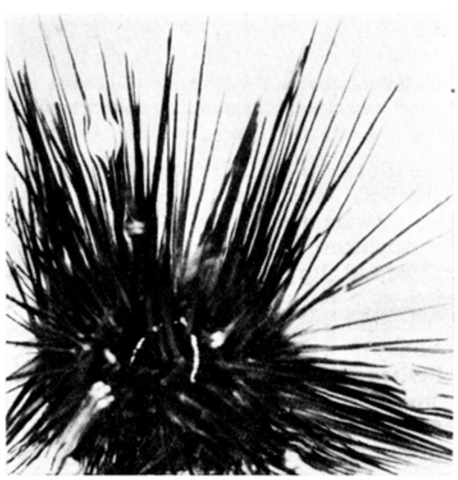

Fig. 2.—A lateral view of an adult after similar treatment but the spines remain intact. Note that the pattern is much less extensive, being restricted to a configuration resembling a lancet arch in the ambital and supra-ambital region of the interambulacrum. Note the lines of the pattern becoming irregular and broken up by the spreading of melanin. ¼:1.

The physiological colour change, which is due to the dispersion and concentration of melanin in superficial chromatophores[2], as previously reported is related in part at least to environmental lighting, young forms which have been in darkness for several hours showing a striking white pattern (Fig. 1) around the periproct and in the spineless areas of the interambulacra (i.e. in those areas which at other times may appear blue). The pattern

[1] N. Millott, Nature *170*, 325 (1952).
[2] N. Millott and F. W. Jacobson, J. Invest. Dermat. *18*, 91 (1952).

is the result of reflection from iridophores[1] situated in the white areas, which are uncovered in darkness owing to the concentration of melanin in the surrounding chromatophores, but as the melanin spreads over the top of them on continued exposure to light, the light reflected by the iridophores becomes increasingly dispersed and a brilliant blue colour results. The white pattern is thus the precursor of the blue.

At first the blue areas form continuous lines, but as the spreading of the melanin continues, the lines disintegrate into irregular spots which become smaller and eventually disappear as the test assumes a uniform black colour. The beginning of this process can be seen in Figures 1 and 2.

The supposedly characteristic blue pattern in *D. antillarum* is thus not a constant feature, for it may take the form of continuous lines or isolated spots, the periproct ring may be present or absent and in some cases the pattern may not appear at all. Its extent and form clearly depend on the degree of dispersion of melanin, in turn dependent on environmental lighting and on an inherent rhythm[2]. The pattern also varies with age, for both red and black pigments accumulate and may obliterate portions of it.

When dispersed, the melanin has a further effect, for it acts not only as a light diffractor but also as an absorber. Thus an urchin appearing uniformly black in ordinary daylight may show the blue pattern when transferred to brilliant sunlight, presumably because all the light is not absorbed by the superficial melanin, some of it penetrating through to become reflected back from the iridophores and further dispersed by the pigment. Here again the extent to which this occurs depends on the amount of melanin and the degree to which it is spread, both of which are continually varying.

It is therefore necessary to be cautious in using the blue pattern of *D. antillarum* as a specific character, for whatever its value in the diagnosis of other species of the genus, it is too variable in the West Indian species to permit simple distinctions to be drawn, and any attempt to use it must take into consideration not only individual variations, but also age, environmental lighting, and rhythmic changes in the dispersion and concentration of melanin.

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Zusammenfassung

Es wird angenommen, dass der Seeigel *Diadema antillarum* sich von ihm nahestehenden Arten in mehreren Merkmalen einschliesslich des blauen Farbmusters auf der Schale unterscheidet, welches die Form von Linien (keine Flecken) besitzt und keinen Ring um das Analfeld bildet. Der morphologische und physiologische Farbwechsel, der kürzlich entdeckt wurde, beeinflusst diese blauen Zonen und macht diese besondere Unterscheidung unhaltbar in ihrer ursprünglichen Fassung. Jeder Versuch, das Farbmuster als ein spezifisches Merkmal zu verwerten, muss eine Reihe von Eigenschaften mit in Rechnung stellen, wie Alter, Beleuchtung der Umgebung und rhythmische Veränderungen der Melanophoren selber.

[1] N. Millott, Nature (in press).
[2] N. Millott, Nature *170*, 325 (1952).