the faculty in charge of the construction of the new wing.

THROUGH the help of the Yellowstone Library and Museum Association, the Naturalist Department of Yellowstone National Park has made progress during the past year. The library which has now been catalogued contains 1,442 bound volumes, 1,862 pamphlets and bulletins, and a large number of magazines and periodicals. Gifts received during the year include original sketches made by Dr. W. H. Holmes and Mr. Henry Elliott, of the Hayden Surveys; an unpublished manuscript by Captain G. C. Doane detailing a trip through Yeulowstone and the Grand Tetons in 1876–1877; also a collection of fossils made by the early members of the Hayden and Hague surveys in Yellowstone Park, loaned by the U. S. National Museum to the Yellowstone Museums.

DISCUSSION

REPORT OF THE SCIENCE ADVISORY BOARD

EARLY in the week of December 9 the president released the report of the Science Advisory Board. About fifty preliminary copies of this report were released to the press. The bound copies will be ready for rather wide distribution to libraries, Congress, government officers, members of the National Academy of Sciences and others during the first week in January.

Quite unexpectedly a large section of the press featured practically the only aspect of the activities of the Science Advisory Board which has not been at least partially successful, and an aspect which was included in the report, merely as part of the historic record of the activities of the board. I therefore feel that a brief explanation may be of interest to supplement the official news release from Science Service which has already appeared in SCIENCE.

The publicity referred to centered around the proposal of a "Recovery Program of Science Progress" which had been presented to the Public Works Administrator on September 15, 1933, for his consideration as a means for providing useful employment to the large numbers of scientists who at that time were being dropped by government bureaus, industrial research laboratories and universities. It was definitely a proposal for emergency employment, designed to enable these scientists to find work of a type in which they could make valuable contributions to problems of social value.

It was proposed to expend a total fund of $16,000,000 on a tapering-off basis over a period of six years, on advice of a committee of scientists to be set up under the National Academy of Sciences and the National Research Council. No program of work was submitted since it was felt that the development of such a program should be one of the functions of the proposed advisory committee. There were, however, submitted a dozen or so examples of scientific or engineering problems of unquestioned social value and promise of successful solution, which were intended merely to illustrate the kinds of things which needed to be done and which might be submitted to the advisory committee and the Public Works Administrator if the plan were authorized.

This proposal was sponsored by some thirty-five executive officers of the national engineering and scientific societies, including the Science Advisory Board. It was submitted to the Public Works Administrator in person, by Dr. Alfred D. Flinn, director of the Engineering Foundation, and myself. After a considerable discussion, Mr. Ickes said that he was 99 per cent. convinced that something of the sort should be done, but that there was unfortunately no provision under the law whereby public works funds could be expended for research but only for construction.

The matter was dropped at that point and was included in the report of the Science Advisory Board only as an historic document because the board assisted in the formulation of the proposal.

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BEHAVIOR PATTERN AND BEHAVIOR MORPHOLOGY

THE word *Morphologie* when first coined by Goethe was used in relation to physical structure. The term still carries physical connotations. But the concepts of morphology can be extended to the phenomena of behavior. Morphology is the science of form. Form is the shape of anything, as distinguished from the substance of that thing. Behavior has shape, temporal and spatial. It is never amorphous. It has pattern in the momentary phase; it has pattern in the series of moments that make an episode; it has pattern when regarded in the full perspective of the life cycle.

The form characteristics of behavior pattern can be investigated in their own scientific right. A morphological approach concerns itself chiefly with problems of form—the description and measurement of specific forms; the systematic study of the topographical relations and the correlation of these forms, their ontogenetic progression and involution, their comparative features among individuals and among species. Any psychological theory which is so ab-

stractly dynamic that it overlooks or slights basic problems of form-production is at least incomplete. The individual is a *morphon* as well as a *bion!*

In the field of developmental psychology it is peculiarly important that the total behavior complex should be envisaged and explored from the standpoint of morpho-genesis. This complex lacks corporeal tangibility; but it does not lack form characteristics. The action systems of embryo, fetus and infant undergo progressive changes of pattern which are so consistent that we may be certain that these changes are governed by mechanisms of form regulation comparable to those which are being established by the science of embryology. Fundamentally, no doubt, the growth of tissues, of organs and of behavior is patterned by identical laws of developmental morphology. It may even prove that certain principles in the physiology of development such as polarity, symmetry, organization center and induction influences will find a modified status in the concepts of psycho-genesis.

The term *behavior pattern* is confessedly protean, but it can not be misleading if the aspect of form consistently receives major emphasis. A pattern of behavior is a configured response which can be concretely described in terms of a given situation. A *behavior item* is a feature or a component of a pattern, ascertainable by analysis. Neither pattern nor item has status as a circumscribed entity. A pattern always has context, and this context if analyzed can in turn be reduced to constituent patterns. But since contexts also have contexts, it follows perhaps that the only pattern which has complete integral status is the organismic pattern which is the individual himself.

Behavior patterns therefore range from minute manifestations, like the wink of an eyelid and the wag of a finger, to the complicated sequences of problem solving and of personality response. A durable task of genetic psychology is to find among the multitudinous patterns of infancy, similarities, modalities and growth-trends which are so fundamental that they give token of the adult, who is to be. This, I would hold, is first of all a morphological or a morphographic task.

A complete description of any behavior pattern would have to take into account the total stimulus pattern as interpreted by Klüver. But coordinate and final consideration must always be given to the form-producing and the form-limiting factors which are resident in the growing organism. Environmental factors inflect, but they do not generate the progressions of development. The maturational matrix is the morphogenetic substratum in which the behavior mechanisms are organized. This matrix is not a diffuse, homogeneous colloidal essence of some kind, but a structured reality which must be scientifically considered in morphological terms.

Now, with this prelude, we may examine a convenient and very suggestive series of behavior patterns, namely those that pertain to the infant's index finger. Let us see whether this finger points to any conclusions.

As early as the eighteenth prenatal week the fetal index finger is capable of spontaneous, undirected movement. But the index finger of the newborn infant remains relatively inactive and is crooked in a clenched fist night and day. In the Yale normative survey the hand posturing of scores of infants was observed while they lay basking in a supine position. The observations, confirmed by cinema records, show that the hands remained predominantly closed in over half of the infants at 4, 6, 8 and 12 weeks of age. But at 20 weeks the hand is predominantly open and the index finger, along with its associates, asserts itself in an interesting pattern of activity, mutual fingering. In this fingering the digits begin to define their separate identities, both as agents and as recipients of impressions. In prehension and manipulation, however, the digits function conjointly, the ulnar digits, as shown by Halverson, taking the lead in functional differentiation.

This retardation in the behavior patterning of the two radial digits, thumb and index, is unquestionably a morphological phenomenon. It is correlated with the very topographic anatomy of these ultimately opposable digits; and is bound up by ramification with far-reaching postural reorientations which involve the wrist, the forearm, the upper arm, the shoulder, eyes and head. The progressive predomination and specialization of the index finger is essentially a process of postural moulding. The inherent morphogenetic character of this process is strikingly displayed in the development of the prehensory reactions to a 7 mm pellet placed before the seated infant at advancing age levels:

At 24 weeks the infant contacts the pellet with pronate hand, in a pawlike manner, with no finger adjustments.

At 28 weeks he flexes his fingers upon the pellet.

At 32 weeks he grasps it by a simultaneous raking flexion.

At 36 weeks he grasps it between thumb and index.

At 40 weeks he approaches and contacts the pellet with extended index. He pokes and pries with his index.

This poking projection of the index is a pattern characteristic so well defined that at 40 weeks it is almost as plain as the nose on his face. It is a new form of behavior, and like the profile of his nose, it is an intrinsic morphogenetic product.

The developmental basis of this poking proclivity

came to very pretty expression in our study of Twins T and C by the method of co-twin control (Gesell and Thompson). Detailed comparative observations of the behavior characteristics of these twins were made. A thoroughgoing identity was established prior to the experimental investigation. On one examination both twins made a raking approach on the pellet, with simultaneous flexion of the digits. Two weeks later under the same conditions each twin approached each pellet with projected index and each twin placed the tip of the index on the pellet. These remarkably similar changes in prehensory pattern occurred contemporaneously, without specific training or imitation.

The preeminence of the index (and thumb) can scarcely be set down as an act of skill acquired primarily by learning. The learning process has no architectonic mechanism which can account for such a topographic alteration of behavior pattern. Training and experience perfect and inflect, but always in specific and immediate confines. They do not engender the basic reconfigurations of behavior. Else, why does not our infant become an expert raker of pellets by gross manual approach, instead of a temporarily ineffectual plucker by refined, digital approach?

It is of crucial significance that the poking propensity asserts itself not only in the presence of small objects like the pellet. The poking is not the consequence of a unique stimulus pattern. The infant pokes in the presence of the cube, the bottle and the bell, as well as the pellet. He may poke in the presence of the extensive, flat-table top. The infant you saw on the screen[1] displayed specialized mobility and extension of the index finger, even when at 40 weeks he stood, eyes front, in his pen outdoors, and raised his free hand toward the circumambient sky. For a brief interval the index pointed heavenward. This behavior denotes the urgency and form-producing character of the internal stimuli which prompt him to poke and pry so inveterately at about 40 weeks of age. The index finger then becomes in fact the *fore* finger.

This poking, however, does not become stereotyped. It never is stereotyped in the normal infant. It begins somewhat sporadically and manifests itself sketchily. Early poking tends to be vague and fugitive; it may involve the thumb and medius; but steadily it defines. It becomes more prolonged; it becomes recurrent; it becomes more penetrating. Interestingly enough for a period the infant merely pokes near or at a hole large enough to admit his index (for example, the half-inch hole in the vertical side of the performance box); only at a later age does he thrust his finger well into the hole. He passes through a transitional period in which both digitally and probably perceptively he fails to penetrate into the third dimensional interior of things. But in due time he probes. His penetration becomes increasingly exploratory and exploitive. In the cinema infant this probing was associated with a mechanical kind of inquisitiveness which has been displayed in numerous life situations and already strongly indicates some form of mechanical aptitude.

New patterns differentiate with maturity, but they never completely individuate; rather, they articulate by ingrowth with concurrent patterns. While they are thus combining, yet newer patterns are differentiating and these in turn will be assimilated to the consolidating total action system. That total action system is an architectured entity, which can be adequately described only in morphological terms. It is the behavioral embodiment of the individual and his constitutional characteristics. Through it the individual as well as the species maintains identity.

The poking propensity and the poking pattern therefore constitute a well-defined example of individuation, a selective specialization of a minor member to subserve the developmental trends or needs of the organism. But that individuation is never complete or segregated, it is always partial and by extensive ramification it remains accessory to a fundamental unity of response.

In the progressive individuations and elaborations which are so palpably, almost naively, exhibited in the behavior patterns of the human fore finger, we have, I believe, a true image of the developmental mechanics of the higher mental processes. Now I do not wish to hang the whole world (and all its psychology) on the infant's extended index, but I would suggest that even in the intellectual spheres of adult invention we are dealing in essence with comparable morphogenetic phenomena. Our mechanistic assumption is that attention in infant and in man is primarily a function of pattern morphology. Acts of attention are dynamic or kinetic manifestations of patterned structure. They have a morphological status. All behavior patterns are therefore subject to morphological investigation.

If this approach is first of all descriptive, well and good. There is no royal road, even in psychology, to an understanding of the structuralization of human behavior. There has been no royal road to the science of human anatomy. We must be prepared to study the phenomena of human behavior with the same minute interest in structured form which the

[1] Prior to the paper, a talking film was shown: "The Growth of Infant Behavior: Later Stages." Yale Films of Child Development (Sound film No. 3, 1934). Erpi Picture Consultants, Inc., New York. See also Gesell, A. *et al.*, "An Atlas of Infant Behavior," Vol. I, pp. 402 *ff.* Yale University Press, New Haven, 1934.

disciplines of embryology and anatomy demand. The way is long and tedious, but the scientific footing is solid.

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Director

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THE ORIGIN OF NATURAL OIL

THE writer of this article is compelled to adhere to his view expressed in SCIENCE of September 7, and questioned by Professor J. M. Macfarlane in the issue for November 23. The reasons are to be found in chemical and geochemical considerations. The specialist in the field of bituminous coal, natural asphalt and oil is struck with the relation of these substances. They consist of aliphatic, semi-aromatic and aromatic compounds. The presence of bituminous coal and oil in the same localities, but in different strata, for instance, near Pittsburgh, forces one to the point of view that both substances were formed from the same original material. If this point of view *and* the fish theory are correct, the origin of bituminous coal and oil would have to be traced back to dead fish. Probably few adherents will be found for such a theory.

The chemical world to-day rejects almost entirely the fish theory. Investigations by P. D. Trask and C. C. Wu[1] have shown that on distillation of samples of sea and lake water muds, which probably contain the remainder of dead fish, oil-like substances can scarcely be obtained. The quantity of oil received therefrom was exceedingly small.

Investigations have shown that under geochemical conditions the teeth and bones of fish remain almost intact. In rocks containing oil fewer inorganic relics of fish are found than undamaged parts of cellulose and wood.

The so-called catastrophe theory has been invented to save the fish theory. The entrance of fresh water into sea water or sea water into fresh water is supposed to have led to the death of enormous quantities of fish. Professor Macfarlane believes volcanic and seismic causes are responsible for this. It is difficult to explain from such a point of view the presence of oil in different strata above each other. Such would mean that catastrophes occurred at the same place at several different times.

Carbohydrates are produced by nature in the greatest degree; probably even more so in earlier periods. The quantity of fish compared to this is small. The presence of enormous quantities of oil in the interior of the earth is therefore contrary to the fish theory. It is more than probable that the savings buried by nature in the form of coal and oil in the earth originate principally in the enormous quantities of carbohydrates and carbohydrate-humic acids transformed therefrom (not lignin-humic acids) and very little, if any at all from fish.

The question of the origin of oil and bituminous coal may be clarified only by experiments and observation of thermo-dynamic, geological and geochemical conditions. The carrying out of experiments should take place under geochemical conditions. In this respect, the writer of this article has to criticize the otherwise valuable experiments carried out by Warren and Storer.[2] Warren and Storer decomposed at "red hot heat" the lime soap which was produced on saponification of fish oil with strong excess of lime. All those who have been engaged with research work on the origin of oil know that neither the action of strong hydrate of lime nor such high temperatures were possible during the formation of oil. At the low temperatures which must be considered here, the lime soap would have to be stable. In any case, it would not lead to the formation of aromatics, such as has been observed in crude oil. From a thermodynamic view-point, the transformation of aliphatic hydrocarbons formed from aliphatic acids into ring hydrocarbons is not possible at lower temperatures. The temperatures required for such transformation are above the temperature for the formation of crude oil, which certainly has not gone beyond 300° C. One can find derivatives of chlorophyll in all crude oils and asphalts. These substances are completely destroyed at temperatures above 300°.

For the formation of aromatic compounds, therefore, other reactions must be responsible. Carbohydrates may be transformed at comparatively low temperatures into semi-aromatics and aromatics (phenols and phenolcarboxylic acids). By such reactions the presence of aromatics and naphthenes in crude oil is not difficult to explain.

On the basis of his own experiments and because of thermodynamic, geological and geochemical facts, which are contrary to the fish theory, the writer of this article can not adhere to the truth of the aphorism that "fish is the source of petroleum." His experimental work and that of his collaborators in this regard will be published elsewhere.

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[1] *Bull. Am. Ass. Petrol. Geol.*, No. 11, 1928, and 1451, 1930.

LUNAR RINGS

ON the evening of November 22, 1934, San Franciscans were treated to a display of spectral rings about the moon. It was first noticed by us from the steps of the Academy of Sciences at 10 P. M.,

[2] "Amer. Acad. Arts and Sc. Memoirs," S2, 9, page 177, 1867.