more of the following steps: (1) primitive, continuous striae; (2) constriction of the striae, occasionally accompanied by swelling, resulting in the formation of nodes; (3) further constriction of these elevations, resulting in rows of round, generally hollow pustules; (4) loss of definite arrangement in these pustules, at least marginally; (5) enlargement of these scattered pustules into short spines. These stages are accompanied by a reduction, relative or actual, in the width of the shell, a consequent increase in tumidity, a reduction in the number and strength of the plications and (generally) a marked increase in the number of growth lamellae.

The progress of evolution, especially in forms which reach stage 4 or 5, may be traced minutely in the ontogeny of the shell. Moreover, there commonly is a close relationship between the duration of a stage in the evolution of a given line and its duration in the life of an individual, as measured in the amount of shell surface on which it is evidenced.

In spite of the regularity of these trends, they are not contemporaneous. One group, in an advanced stage of pustulation, will be contemporaneous with another in which stage 2 has been reached, and a third in which striae are primitive and continuous. In every line advanced stages of evolution, both in striae and gross characters, are followed by disappearance, and disappearance also is non-contemporaneous. These facts, plus a lack of evidence of progressive environmental change, negate the theory of natural selection, while the uniformly determinate, even predictable, nature of the changes, militates against heterogenesis.

It seems, therefore, that in the *Spirifer orestes* phratry we have numerous, parallel examples of determinate or orthogenetic evolution, operating independently of the environment and resulting regularly in extinction of the lines affected. Such evolution commonly is interpreted as racial senescence, although that theory generally has involved such factors as gigantism, multiplication of structures and extreme spinescence, which are lacking in the *Spirifer orestes* phratry.

There are several lines of evidence, however, which support Child's hypothesis of racial senescence through heritable, cumulative decrease in the rate of basal metabolism as an interpretation of these evolution trends.[5] One is the minute correlation between ontogeny and phylogeny, which strongly suggests a community of cause. Another is the fact that phylogerontic members of any given line more commonly show injury than do phyloephebic ones, and have repaired those injuries much less effectively. In the latter, valves fractured during neanic growth may be so well repaired that the injury is not shown ephebically, while in the former, injuries too small to be distinguished clearly commonly distort the entire shell. Finally, phylogerontic forms seem to have been extremely susceptible to physiologic disturbance, their shells bearing abundant and pronounced growth lamellae and constrictions. These, like incapacity for repair, seem to indicate a lowered metabolism in the organisms concerned.

Evidence gleaned from the *Spirifer hungerfordi* gens is less conclusive regarding precise trends than is that from the *S. orestes* phratry. On the other hand, it is quite as definitely negative toward theories of selection and environmental influence, since widely divergent groups develop contemporaneously in the same spots. Evidence from injury, repair and growth disturbance is virtually identical and affords the best indication that a common evolutionary process underlies the divergent trends just mentioned.

From the evidence here briefly summarized, a theory of the racial life cycle is advanced which may be stated as follows.

Stages in the life history of a race may approximate those in that of the individuals composing it, and in such cases, rest upon the same physiologic basis. Changes involved in racial origin, in such series, find their cause in genetic variations which increase the metabolic rate; those of differentiation and decline (racial senescence) in heritable variations which reduce that rate.

CARROLL LANE FENTON
UNIVERSITY OF BUFFALO

[5] "Senescence and Rejuvenescence," 193–194, 463–464, 1915.

CHANGES OCCURRING IN STORED ALCOHOLIC PLANT EXTRACTS[1]

PHYTO-CHEMISTS have used the alcoholic preservation method for the storage of plant materials for a considerable number of years. Surprisingly small, however, is the amount of work that has been done to explain the reasons for each step, and practically nothing has been done to check the effects of such a procedure on the various constituents to be estimated. There are such statements as, "Preserved in 80 per cent. alcohol," and "Calcium carbonate added to neutralize the acidity," and theoretical considerations are found to justify such statements. As previously stated, it is very hard to find analytical data to explain the reason for these steps. It is coming to be recognized that nitrogen fractionation must be completed on water extracts. A previous paper[2] from

[1] Published with the permission of the director of the Oklahoma Agricultural Experiment Station.

[2] J. E. Webster, "Effects of Storage on Alcoholic Extracts, I. Amino Acid Changes," *Plant Phys.*, 4: 141–4, 1929.

this station has shown that under certain conditions ordinarily met with, the alpha amino nitrogen percentage decreases while in storage. Work on the factors responsible for these changes is progressing but of necessity must cover a long period of time and involve a great number of factors. Several interesting results have been secured to date, and it is felt that they are of enough importance to the field of plant chemistry to be published prior to the main body of the work which will be published at a later date.

One of the most interesting facts discovered is that the term "calcium carbonate added to neutralize the acidity" is most uncertain. Plant samples prepared in the usual manner by adding an excess of $CaCO_3$ have been found in most cases to be distinctly acid, the amount of acidity, of course, depending upon the material preserved. Approximate hydrogen ion determinations have been made on a number of solutions using the colorimetric procedure, and they have been found to range from pH 4.6 to 6.0. The following figures may be given as an example of their acidity. Five cc portions of several of these samples were brought to approximate neutrality, using N/10 NaOH.

Plant	1	4. drops	N/10	NaOH
"	2	3. "	"	"
"	3	4. "	"	"
"	4	8. "	"	"

From these figures it is at once apparent that the acidity varies considerably, and the solution being acid even when treated with $CaCO_3$, changes may result that we did not expect on theoretical grounds. Perhaps the acidity has little, if any, bearing on carbohydrate changes in these stored extracts, but until all the conditions surrounding this point are critically examined, we must hold such determinations at least open to question. A recent publication[3] takes note of this fact and brings alcoholic solutions to a pH of 5.8 to 6.0 using tenth-normal NaOH to neutralize the acidity of the extracts. This procedure must certainly be recognized as a great advance over the addition of an excess of $CaCO_3$.

While the importance of acidity is not so apparent in the carbohydrate analyses, in the nitrogen changes it is most important, as the following figures show, at least, on the amount of ammonia present. Only one set of figures is given but they are representative. Samples were prepared and analyzed as outlined in my previous work.[2]

[3] Nightingale, Addoms and Blake, "Development and Ripening of Peaches as Correlated with Physical Characteristics, Chemical Composition, and Histological Structure of the Fruit Flesh: III. Macrochemistry," N. J. Agr. Expt. Sta. Bull. 494, 1930.

TABLE I

pH 4.2		pH 8.+	
Date	NH_3	Date	NH_3
2–27–29	2.72	2–27–29	2.14
3–12–29	2.90	3–12–29	4.60
5–22–29	4.00	5–22–29	7.89
11– 7–29	4.62	11– 7–29	8.50

Celery extract in approximately 80 per cent. alcohol. Ammonia in terms of N/50 HCl.

From Table I we see that there is a continuous increase in the amount of ammonia and that this increase is much greater in the alkaline solution. In all the solutions examined (grapes, celery, lettuce, spinach) there has been found some increase in ammonia on standing, both in acid and alkaline solutions. In some, however, the increase has been small and perhaps in samples of other materials would be negligible.

No explanation of these changes can be given until further work is completed, but on the basis of the present work it does not seem that the increase in ammonia results from a deaminization of amino acids even though we do know that the amount of alpha amino nitrogen decreases in some of these solutions.

In conclusion it seems that this question of alcoholic storage has not received the attention it should and that to make our plant analyses of value when we use this procedure a host of questions bearing on this field should be answered. This laboratory is continuing its work, but the need for some satisfactory method of preserving plant material for analyses is so pressing that it offers a ready field to the experimenter, and one that should well repay the research workers.

JAMES E. WEBSTER
OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

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