6. The apparatus consisted of mercury arc (BH6, General Electric Co.), monochromators (Bausch and Lomb Optical Co.), photomultiplier tube (6903, Radio Corporation of America), and recorder (Brown Instrument Co.). The activation of the phosphorescence spectra consisted of a region from 280 to 310 mμ.
7. Sources of our materials: Serotonin was used as serotonin creatinine sulfate kindly furnished us by Dr. K. E. Hamlin, Jr., Abbott Laboratories, North Chicago, Ill., and by Sandoz Pharmaceuticals, Hanover, N.J. Both sources gave identical spectra. Reserpine was furnished by Mr. Louis Dorfman, Ciba Pharmaceutical Products, Summit, N.J. Indole was purified by crystallization and by several successive sublimations. Tryptamine hydrochloride, L(-) tryptophan, and indoleacetic acid, Eastman Organic Chemicals.

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Effect of Post Partum Separation of Mother and Kid on Maternal Care in the Domestic Goat

Abstract. Twenty-four goat mothers were separated from their newborn kids for 1 hour immediately following birth. Two months later these mothers were observed to nurse their own kids less and alien kids more than nonseparated mothers. Separation of mother and young in half the flock also resulted in abnormal "rejecting" behavior in some nonseparated mothers.

Recent studies (*1*) have demonstrated that the appearance of some types of normal, species-typical maternal behavior, often classed as "instinctive," is dependent upon the occurrence of specific experiences during critical periods in the life of the individual animal. Experimental or accidental changes in the "natural" environment at these times often result in the development of decidedly abnormal, species-atypical behavior.

Domestic sheep and goats normally rear their young within an individual-specific family structure. The suckling relationship between mother and young is typically limited to a particular parent and her offspring, and any attempt by a lamb or kid to nurse, or sometimes even to approach, a mother not its own results in that mother's withdrawal from and often violent repulsion of the alien offspring.

Descriptions of sheep and goat parturition indicate that the experience of the mother immediately following birth is critical to the development of this individual-specific infant-rearing pattern. Separation of mother and newborn for a short time at birth results in at least the temporary rejection of the young by the mother when mother and offspring are reunited (*2*).

Some observations of the behavior of separated mothers, however, suggest that maternal behavior often is unstable. Separated mothers who at first reject their own or foster young may occasionally later accept them, and mothers who at first accept young sometimes later reject them (*2, 3*). The study described in this report was undertaken to investigate the long-term, general effects of early mother-young separation on the individual mother and on the population as a whole.

Twenty-four domestic goat mothers were separated from their newborn kids for periods ranging from ½ hour to 1 hour, 5 to 10 minutes immediately following birth. The kids were permitted, or helped, to nurse their own mothers when mother and kid were reunited. A control group of 21 mothers, equated for age and parity, were allowed to follow the normal newborn care-taking pattern. The usual life of the flock was not specifically interfered with further until approximately 2 months (Table 1, observation 1) and, again, 3 months (Table 1, observation 2) after birth, when mother-kid interaction was studied in the following manner.

All the kids in the flock were housed in a room apart from all the adult goats for from 6 to 10 hours. The kids were deprived of both food and water during this time; the mothers received food and water as usual. Three of the kids, of approximately the same age, were then brought into the experimental room. One minute later the mother of one of the three kids joined them, and all four were observed for 15 minutes through a one-way-vision glass. An observer recorded the time in seconds of the mother's nursing and butting behaviors by activating separate electric clocks for the duration of each type of behavior as it occurred. This procedure was repeated until each mother had been observed with her kid and two others.

In each instance, the three kids appeared highly excited and fearful when they were first brought into the unfamiliar room. With the appearance of the mother, all three kids rushed toward her and attempted to nurse. The immediate reaction of all the mothers was to back away from this onslaught for the first 30 seconds. After this initial period, most nonseparated (control) mothers began the process of establishing a private territory for herself and her own offspring, by butting away the two other kids each time they approached her. After several minutes of being butted the other kids kept their distances, while the mother nursed her own kid in the usual manner.

In contrast, the separated (experimental) mothers behaved in a distinctly abnormal manner during both observation periods (Table 1), nursing their own kids less than the nonseparated mothers ($p = 0.01$) and nursing other kids more ($p = 0.01$). Separated mothers nursed other kids as long as they nursed their own, whereas nonseparated mothers nursed other kids relatively little, as compared with the time spent nursing their own ($p = 0.01$) (mean differences were tested for significance by t tests, which were computed separately for each observation period).

All butting behavior for both groups was normal; none of the mothers butted their own kids, although they butted other kids frequently.

An unexpected result of the study was the appearance of "rejecting" behavior (nursing neither their own nor other kids) among the mothers of the nonseparated group. Similar experimental analysis of the *post partum* behavior of another herd in which none of the kids had been separated at birth revealed no instances of "rejecting" behavior or of "indiscriminate" behavior (nursing other kids as long as, or longer than, their own), suggesting that the act of separating half the kids in the experimental herd had probably been the principal factor affecting maternal-young relationships of the nonseparated "rejecting" mothers. Although the specific cause of this effect on the nonseparated mothers is unknown, the "rejecting" behavior of the nonseparated mothers may have developed because their own kids wandered off shortly after birth and were

Table 1. Mean duration, in seconds, of maternal activities occurring during the 15-minute observation periods.

Condition	Separated mothers ($N = 24$)		Nonseparated mothers ($N = 21$)	
	Observation 1	Observation 2	Observation 1	Observation 2
Nursing own kids				
Mean	36.2	23.2	50.4	61.8
Standard deviation	11.4	9.7	16.5	22.3
Nursing other kids				
Mean	37.2	27.6	7.1	10.5
Standard deviation	9.3	10.1	6.8	8.8
Butting own kids				
Mean	0.0	0.0	0.0	0.0
Standard deviation	0.0	0.0	0.0	0.0
Butting other kids				
Mean	16.1	14.8	19.3	13.9
Standard deviation	15.3	12.6	15.7	10.0

accepted by the separated-"indiscriminate" mothers, since both separated and nonseparated mothers were kept together as one flock except for the short period during which the experimental mothers were separated from their young. Separation of some of these highly gregarious animals had thus influenced the social structure of the herd as a whole, changing the behavior of "control" animals whose early *post partum* experiences had not deliberately been disrupted, but whose environment had been affected in turn by abnormal maternal and filial behavior produced in the experimental members of their group (*4*).

LEONARD HERSHER
Department of Pediatrics,
College of Medicine,
State University of New York,
Syracuse

A. ULRIC MOORE
Behavior Farm Laboratory,
Cornell University,
Ithaca, New York

JULIUS B. RICHMOND
Department of Pediatrics,
College of Medicine,
State University of New York,
Syracuse

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4. This study was conducted at the Behavior Farm Laboratory of Cornell University and was supported in part by grants from the Josiah Macy, Jr. Foundation and the Ford Foundation. We thank Dr. Howard Liddell, director of the laboratory, and Dr. Helen Blauvelt for advice and aid in planning and in carrying out this study.

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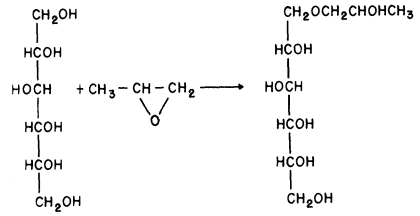
Rigid Urethane Foams Based on Sorbitol Derivatives

Abstract. Present commercial rigid foams are based on polyester raw materials. It has now been demonstrated that certain hydroxyl-terminated polyethers can be used satisfactorily as a major component of rigid urethane foams. These polyethers are hexafunctional materials prepared by reacting propylene oxide with sorbitol.

Commercial rigid urethane foams are prepared at present by reacting a suitable hydroxyl-terminated polyester with tolylene diisocyanate, water, and catalyst. Foaming commences, and the resulting foam is cured under the proper conditions.

Polyesters have been employed in such rigid foam preparations because of their multiple functionality and cross-linking potential. The multiple functionality is ordinarily obtained by the incorporation of glycerol in the polyester, with a branch or side chain arising at each glycerol molecule in the backbone of the polyester chain. In this way, by regulating the glycerol content, it is possible to obtain polyesters of high, moderate, and low degrees of branching. Generally speaking, polyesters used in rigid foams are highly branched, those in flexible foams are unbranched, and those employed in semirigid foams are moderately branched.

By contrast, at the present time, essentially no commercial rigid foams are based on polyethers. It has recently been demonstrated in this laboratory that certain highly functional hydroxyl-terminated polyethers can be used as a major component of rigid urethane foams. These hexafunctional polyethers are prepared by reacting propylene oxide with sorbitol. The addition of the first molecule of propylene oxide to sorbitol can be visualized as follows:



The reaction is carried out at elevated temperature and pressure in the presence of a suitable catalyst. More and more molecules of propylene oxide can be added until there are long chains of proplyene oxide extending from the sites of the original hydroxyl groups of the sorbitol molecule. The initial attack is most heavy on the primary hydroxyls, but after all hydroxyls become secondary the probability of attack at each hydroxyl is perhaps roughly equal to the probability at any other hydroxyl. The final product can be described as a hexafunctional molecule bearing six secondary hydroxyl groups of approximately equal reactivity toward isocyanate. Such products have been prepared with propylene oxide/sorbitol mole ratios of 10/1, 20/1, 40/1, and 80/1. These are pale to colorless free-flowing liquids that are soluble in a variety of solvents.

The molecular weights and approximate hydroxyl numbers of these materials are shown in Table 1.

The compounds of smaller molecular weight have higher hydroxyl numbers and will consequently produce higher concentrations of cross-links in the resulting urethane polymer formed by reaction with tolylene diisocyanate. On the other hand, propylene oxide/sorbitol in the mole ratio of 80/1 produces a much lower concentration of cross-links per unit of mass, and hence might well find use at a suitable concentration in semirigid and flexible foams, as well as in rigid foams.

Table 1. Molecular weights and approximate hydroxyl numbers of products prepared with propylene oxide/sorbitol in various mole ratios. The hydroxyl number is defined as milligrams of potassium hydroxide equivalent to the hydroxyl groups present in 1 gram of compound.

Mole ratio of propylene oxide/ sorbitol	Molecular weight	Hydroxyl number
10/1	760	440
20/1	1340	250
40/1	2500	130
80/1	4830	70

Several of the materials listed in Table 1 have now been used to prepare rigid urethane foams by techniques that are widely known. For example, a foam was formulated from 300 parts (by weight) of 10/1 propylene oxide/sorbitol, 246 parts of tolylene diisocyanate (80/20 isomer ratio), 6.0 parts of water, 1.5 parts of silicone oil, and 0.3 parts of alkaline catalyst. After foaming was substantially complete, the foam was cured for 3 hours at 100°C. The rigid foam produced was white and had a fairly uniform cell size. It had a density of 4.1 lb/ft.^{3} Its compressive strength was 47.8 lb/in.^{2} at 25 percent compression, and 60.1 lb/in.^{2} at 50 percent compression.

The unique property of these new polyether foam ingredients is their high functionality, which causes them to approach the polyesters in cross-linking efficiency. It may also be noted that foams based on polypropylene oxide/sorbitol contain no ester linkages and hence may be more resistant to hydrolytic degradation by dilute acids and alkalis. The high functionality of polypropylene oxide/sorbitol compounds also makes them potentially valuable ingredients in polyurethane coatings and adhesives. One laboratory (*1*) has already observed that the incorporation of sorbitol itself in castor oil/tolylene diisocyanate coatings results in increased coating hardness, speed of cure, tensile strength, and solvent resistance.

This research is being extended at present to an investigation of the incorporation of propylene oxide derivatives of other hexitols in polyurethane foams and coatings.

JOSEPH E. WILSON
RAYMOND H. FOWLER
Atlas Powder Company,
Technical Center, Wilmington, Delaware

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