A note on the semiotics of biological mimicry

Timo Maran

The term 'mimicry' is quite widely used nowadays. One can find it in most different areas: in psychology and education, where child is mimicking his or her's parents (Kuczaj 1998), in economy, where different products are similar (Daughety, Reinganum 1997), in anthropology, where native people are acting like us (Huggan 1997; Met 1996), in immunology and molecular biology where the immunosystem is not able to distinguish different proteins with similar structure (Requejo 1997; Wucherpfennig 1997), in ornithology where young birds are learning singing from the adults (Eens, Pinxten 1992), etc.

The wide use of the word makes the meaning of the term 'mimicry' inevitably indistinct and it is easy for one to lose the concept. However, the notion of 'mimicry' in biological and biosemiotic sense is quite well definable, as I will explain below. Generally speaking, we should distinguish two different concepts, which are often confused — similarity and imitativeness. In the first one, there is no internal connection between two objects, which seem similar to us; in the second case one object is somehow caused or affected by other. Mimicry in animate nature is a very complex phenomenon, which deeply differs from similarity relation of the physical realm, and it seems to be strongly semiotic also.

Historical overview

In 1861 H. W. Bates discovered 'imitative resemblance' in Amazonian butterflies *Heliconiidae* (Bates 1862, 1867). This event marks the beginning of mimicry research. Nineteen years later F. Müller

created a new concept of mimicry to explain similarity of warning colorations among insects (Müller 1878). In the last decade of the nineteenth century E. Poulton published several papers about mimicry in the context of natural selection theory (Poulton 1890, 1898). Contributions by H. Cott and F. Heikertinger should also be mentioned as highly significant (Cott 1940; Heikentinger 1954). In 1967, Wickler created a new concept of mimicry systems using terminology of information theory (Wickler 1967). From that point forward mimicry has been seen as ecological set-up that includes two or more protagonists, performing three roles: being a *model*, being a *mimic*, and being a *dupe* (Fig. 1).

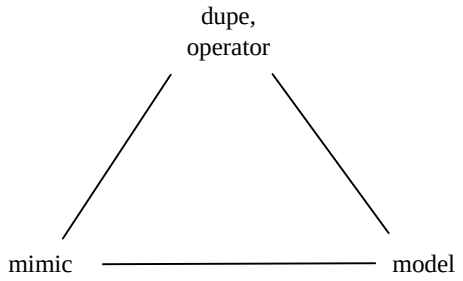

Fig. 1. Every mimicry system includes three components: model, mimic and dupe. If one of these participants is missing, the whole system will lose its idea.

According to G. Pasteur,

> ***model*** *is a living or material agent emitting perceptible stimuli or signals*; ***mimic*** *is an animal or plant that simulates the model*; *and* ***dupe*** *is an animal enemy or victim of the mimic whose senses are receptive to the model's signals and which is thus deceived by the similar signals of the mimics* (Pasteur, 1982). If one of these participants is missing, the whole system loses it's idea.

Another definition has been given by Derlbert Wiens:

> ***Mimicry*** *is a process whereby the sensory systems of one animal (operator) are unable to discriminate consistently a second organism or parts thereof (mimic) from either another organism or the physical environment (the models), thereby increasing the fitness of mimic* (Wiens 1978).

These concepts themselves are strongly semiotic, because the terms model, mimic, and dupe or operator are defined through the transmission of signals and the protagonists relations to the transmitted information.

Terms and concepts such as eucrypsis, mimesis, Müllerian resemblance and others have also been used in several papers, in some cases as subdivisions of mimicry, in some cases separately. According to G. Pasteur there are still very different points of view about contents of these terms (Pasteur 1982). But generally speaking we can distinguish four major categories, which can be divided further. The first category includes the terms: eucrypsis, crypsis, camouflage, protective coloring, color imitations. In these cases, colors of mimic are similar to the natural background. The second is mimesis, which in some cases are divided as cryptic and phaneric mimesis. In this case both the forms and colors are imitated. The third includes Batesian, Mertesian, Peckhammian and other mimicry systems, where the model is a living being, that elicits a reaction in the signal receiver. The fourth is Müllerian mimicry or Müllerian resemblance where different noxious organisms have similar forms and colors.

Still, I would like to point out, that there are some very detailed classifications, for example G. Pasteur's classification, where mimicry systems have been divided according to the nature of the model, species composition type and function (Fig. 2) (Pasteur 1982).

The concept of mimicry is often seen in evolutionary context and in the 18th century it has been used as a strong argument for the Darwinian evolutionary and natural selection theory. Anyway, it seems important, that through the evolutional feedback loops, mimicry systems have certain dynamical stability.

On the one hand, these feedback mechanisms appear as balances between populations of models, mimics, and dupes in the same way as balances between populations of predators and pray-animals appear in Lotka-Volterra equation-systems.

On the other hand, these feedback mechanisms regulate a set of signals. Signals of mimics, which operators cannot recognize correctly will develop, but in the extent, it is possible from the natural material.

Mimicry	Species composition of the system	Function
Model Forbidding to the Dupes		
Batesian	Disjunct	Protective
Emsleyan	Disjunct	Protective
Gilbertian	S_1R/S_2	Protective
Browerian	$S_1\ S_2/\ R$	Protective
Wicklerian-Guthrian	Conjunct	Aggressive
Model Agreeable to the Dupes		
Wicklerian-Eisnerian	Disjunct	Aggressive
Vavilovian	Disjunct	Aggressive/ reproductive/ mutualistic
Dodsonian	Disjunct	Reproductive
Batesian-Wallacian	$S_1\ R/\ S_2$	Aggressive
Kirbyan	$S_1\ R/\ S_2$	Aggressive/ reproductive
Pouyannian	$S_1\ R/\ S_2$	Reproductive
Wasmannian	$S_1\ R/\ S_2$	Mutualistic, commensialist
Batesian-Poultonian	$S_1\ R/\ S_2$	Protective
Nicolaian	$S_1\ /\ S_2R$	Reproductive
Bakerian	$S_1\ S_2/\ R$	Reproductive
Aristotelian	$S_1\ S_2/\ R$	Protective
Wicklerian-Barlowian	$S_1\ S_2/\ R$	Reproductive
Wicklerian	Conjunct	Protective

Fig. 2. Mimicry classification by G. Pasteur (1982). Within the two major classes, mimicry systems are ranged according to species composition type (*disjunct* — all the protagonists are different species; *conjunct* — all the protagonists belong to the same species; $S_1\ R/\ S_2$ — model and dupe belong to the same species; $S_1\ /\ S_2R$ — mimic and dupe belong to the same species; $S_1\ S_2/\ R$ — model and mimic belong to the same species), and within each type of species composition according to function.

Therefore, the similarity between mimics and models is never absolute, but always rough and close, controlled partly by recognition, partly by evolutionary possibilities. I think this mechanism is similar to these, which insure the stability of natural languages, only upside

down, so the signals, which are not correctly recognized, are preferred.

Introducing semiotical approach

Although Th. Sebeok in his book "Essays in Zoosemiotics" has suggested observing mimicry-systems on the assumption of semiotical framework, there have been no serious attempts in the field yet (Sebeok 1990).

I suggest that Ch. Peirce's sign theory and it's explications by Ch. Morris provide an appropriate theoretical basis for looking mimicry in a semiotic context. In animate nature, we can observe organisms with concrete properties in their environments, responding in their specific way to the various situations. As J. v. Uexküll suggests, from that basis we can derive conclusions about the meanings of signals and signs for different organisms (Uexküll 1982). Linguistic tradition, on the contrary, presumes that we have some *a priori* knowledge about the meanings of signs, which limits the use of theories based on the Saussurean tradition in the biological field. Terminology used by Morris can easily be adjusted for different occurrences of biological communication as mimicry (Fig. 3).

Terms used by Ch. Morris (1938)	Termsused in biology to describe mimicry (Wiens, 1978; Pasteur, 1982; etc.)
sign vehicle	mimic and model
designatum	searching image
interpretant	dupe, signal receiver (with his specific reaction)

Fig. 3. Correspondences between semiotic terms used by Ch. Morris and biological terms used by various biologists and ethologists.

At the first sight, it is not easy to see any possible connection between the phenomenon of mimicry and J. v. Uexküll's Umwelt theory. Furthermore, in his works Uexküll almost does not mention mimicry or natural resemblance. However, from the other side there are signs in the animate nature, which function as delusions for certain signal

receivers but are not detectable or deceptive for human senses. For instance some moths are making ultrasonic signals to deceive bats, and an orchid — the red helleborine *Cephalantera rubra* is similar with several bellflowers *Campanula sp* for the eye of the insect, but not for human observer. Therefore, the objects, which are similar in one Umwelt, may easily be distinguished in an other Umwelt, and unperceivable in a third. So mimicry, mimetic resemblance, camouflage and other similar phenomena always depend on the Umwelten and the concrete natural background or context as well.

In mimicry, we are not dealing with primary semiotic interaction, where interpretators derive meaning from objects of the physical realm. Rather the mimicry question is about finding or not finding difference between two similar objects or signs by derived meanings (Fig. 4). Therefore, the problem of signal receiver is not to recognize, but to recognize a difference. Hereby the phenomenon of mimicry is strictly connected with problems of discreteness and distinguishability of signs.

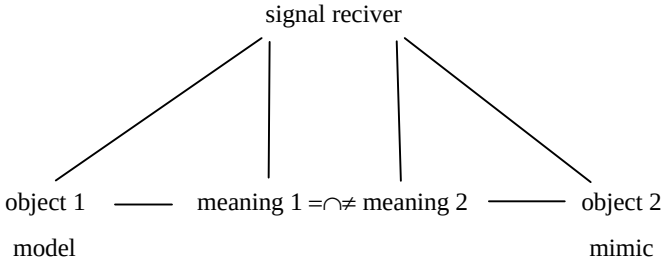

Fig. 4. Sign structure of mimicry.

The receiver must decide on difference or uniformity of two objects. However, situations, where both objects are performed to the receiver at the same time are not very usual in animate nature. Mostly the recall of the model is carried by the signal receiver.

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Заметки о семиотике биологической мимикрии

Несмотря на то, что понятие мимикрии стало за последнее десятилетие широко употребляться, значение и объем этого понятия в биологии и биосемиотике можно довольно точно очертить. В биологии под мимикрией понимается знаковой процесс, в ходе которого между живыми организмами происходит передача, восприятие и ложное понимание информации. Тем самым мимикрия может быть и объектом семиотического изучения.

Начиная с работ В. Виклера (1968) мимикрия описывается как акт коммуникации, в котором участвуют: *мимет*, организм, который подражает свойствам, характерным для какого-либо другого вида; *модель* — характерные черты которого становятся объектом подражания и *узнаватель*, организм, который должен, но не может различить мимет от модели.

Системы мимикрии являются самосохраняющимися структурами, стабильность которых поддерживается механизмами обратной связи в цепи мимет-модель-узнаватель, которые напоминают механизмы, характеризующие развитие и устойчивость естественного языка.

В случае мимкрии мы не имеем дело с примарным знаковым отношением, когда из объекта выводят значение. Процесс мимикрии является, скорее, процессом различения двух похожих носителей знака на основе выводимых значений. Т.е. для узнавателя важно не узнавание, а узнавание различия. Таким образом, феномен мимкрии тесно связан с проблематикой различия и дискретности сигналов и знаков.

Märkusi bioloogilise mimikri semiootikast

Olgugi, et ‘mimikri’ mõistet on viimasel kümnendil kasutatud rohkesti erinevates ainevaldades, võib öelda, et selle mõiste tähendus bioloogias ja biosemiootikas on küllalt täpselt piiritletav. Bioloogilises tähenduses on mimikri märgiline protsess, mille käigus toimub informatsiooni edastamine, vastuvõtmine ning vääritimõistmine elusolendite vahel, ning seega peaks mimikri kuuluma ka semiootika huvisfääri.

Alates W. Wickleri töödest (1968) on valdav mimikri kirjeldamine kolmest osapoolest koosneva süsteemina: **mimeet** (*mimic*) on organism, kes jäljendab mõnele teisele liigile või mõnele laiemale rühmale omaseid jooni; **modell** (*model*) on organism, kelle välimust, käitumist, lõhna, häält vms. omadusi jäljendatakse; **äratundja** (*receiver*) on signaali vastuvõtja, organism, kes peaks, ent ei suuda mimeeti ja modelli eristada.

Käesolev artikkel määratleb mimikri semiootilise kirjeldamise lähtekohad.

Mimikrisüsteemid on ennastsäilitavad struktuurid, mille stabiilsus tuleneb mimeedi, modelli ja äratundja vahelistest tagasiside-mehhanismidest. Need mehhanismid sarnanevad neile, mis iseloomustavad loomulike keelte arengut ja püsimist.

Mimikri puhul pole tegemist primaarse märgisuhtega, kus objektist tuletatakse tähendus. Mimikri protsess on pigem erinevuse leidmine või mitteleidmine kahe sarnase märgikandja vahel nendest tuletatud tähenduste kaudu. Niisiis pole äratundja jaoks küsimuseks mitte äratundmine, vaid erinevuse äratundmine. Seega haakub mimikri fenomen otseselt signaalide ja märkide erisuse ning diskreetsuse probleemistikuga.