



MARINA VANČATOVÁ, VÁCLAV VANČATA

THE SIMPLE OBJECTS PLACE IN ENCLOSURE FOR GORILLAS INITIATE RARE OR NEW BEHAVIOURAL PATTERNS - IMPLICATIONS FOR THE ORIGIN OF HOMININE TOOL BEHAVIOUR

ABSTRACT: Our results demonstrate that very simple objects for environmental enrichment can initiate more types of behaviour in the group of gorillas or provoke the new or innovative behavioural patterns. There are three types of objects: plastic boxes and wooden baskets; wooden shaving; long tools, branches and toys. We observed the group of gorillas in Prague Zoo (2009–2018). All animals use these three types of objects daily and include them in the different types of behaviour (play, agonistic, sexual, social, comfort). Boxes and baskets used as a step-stools or seats, weapons, drums as drummers and for the increase effects during chest beating, for the sweeping garbage. Baskets are used for hiding. Wooden shaving used as a pads, making of a primitive slippers (and all youngsters learn this behaviour from their mother), as a neck protectors, as a cushion, use to a clean of the body, creating "Islands" during traveling through the new substrate place. Blocking the photocell on drinking by the wooden shaving enable the use water all the time. After making of primitive slippers gorillas used them for the moving on the wet or cold floor. Our study proves that gorillas are able sophisticated tool behaviour. They do not show much tool modifications, however, the degree in using innovations and active tool using is relatively very high. Some features of their tool activities indicate the origin of traditions, like using of plastic boxes or wooden-shaving slippers. These results show that environmental enrichment could reveal mechanisms of formation of early hominine tool behaviour and relations of using tools to the development of early hominine cognitive abilities.

KEY WORDS: Gorilla - Tool behaviour - Environmental enrichment

Received 12 November 2019; accepted 9 April 2020.

© 2021 Moravian Museum, Anthropos Institute, Brno. All rights reserved.

DOI: <https://doi.org/10.26720/anthro.20.01.17.1>

INTRODUCTION

One of the most important question of evolutionary anthropology is to explain origin and early development of hominine tool behaviour, which has had a specific adaptive meaning for earliest hominines having very probably different cognitive background that of ape tool behaviour (Boesch 2012, Carvalho *et al.* 2009, Harmand *et al.* 2015, Hayashi *et al.* 2005, Luncz *et al.* 2015, Langergraber *et al.* 2015, Mercader *et al.* 2002, Miller 2005, Potts 2004, Vogel 2002). Tool behaviour of the great apes provides usually good background for the modelling of such evolutionary processes. However, there are many problems that seriously prevents to suitable model for the early hominine tool behaviour (Mercader *et al.* 2002, Vogel 2002). One of the problems is comparability of ape tool behaviour in the wild and in captivity.

While cognitive abilities are comparable among the great apes, tool behaviour differs. Chimpanzees, and up to some degree also orangutans (Van Schaik, Knott 2001), are very active using object for manipulative behaviour. We can describe them in various types of behaviour and even local traditions (Alp 1997, Biro *et al.* 2003, Dutton, Chapman 2015, Hicks *et al.* 2019, Koops *et al.* 2013, 2014). Quite in opposite tool behaviour is quite rare in gorillas living under natural conditions (Deblauwe 2009, Kuroda *et al.* 1996, Wittiger, Sunderland-Groves 2007, Vančatová 2011). Even more striking fact is that there are the differences between the behaviour in the wild and in captivity in individual ape species (Lonsdorf, *et al.* 2009).

Chimpanzees are very active in captivity but profile behaviour changes, naturally – sources of food (Hicks *et al.* 2019, Koops *et al.* 2013, 2014), the orangutans are reasonably active even in captivity (Mulcahy *et al.* 2005, Vančatová 2011), however, for gorillas in captivity could be the active tool use relatively high (Vančatová 2011).

From these reasons very frequently used model based on chimpanzee behaviour is unrealistic for testing the hypothesis of the influence of the environment because feeding tool behaviour prevails in the wild living chimpanzees while it is much less frequent in chimpanzees in captivity (Biro *et al.* 2003, Celli *et al.* 2004, Hicks *et al.* 2019, Koops *et al.* 2013). It is necessary that there must be the relative proportionality between feeding behaviour in the wild and in the captivity to create model of environmental influence on tool behaviour with respect to the development of cognitive processes towards changes of environment.

For gorillas in captivity proportionality does not substantially vary in comparison to the wild living population and tools are used for getting food quite rarely (Koops *et al.* 2014, Van Carsteren *et al.* 2019, Nakamichi 1999, Vančatová 2011). From these reasons captive gorillas can be used to test a model of influence of specific environment to origin of innovative tool behaviour. Gorillas at a zoo are getting a rather high-quality food (Tennie *et al.* 2008, Vančatová 2011), so, in theory, enrichment the environment can stimulate new types of tool behaviour and new approaches to spontaneous using tools (Potts 2004).

In other words, changes in tool behaviour and cognitive behaviour of gorillas could be significantly changed by environmental enrichment handling (*sensu* Potts 2004) in connection with the use of objects in the surrounding area to improve "the conditions"

Methodology of environmental enrichment

Environmental enrichment is a very important factor improving the quality of life in captive primates (Lutz, Novak 2005, Vančatová, Vančata 2011, Vančatová *et al.* 1994). It is of a special importance in great apes, primates most related to human species. However, there are some specific problems in apes, namely a lot of visitors and relatively small secluded areas in relation to their size and activities. We have studied apes for several decades and, in our opinion, environmental enrichment has many specific problems. Apes are very powerful, and their youngsters are very active.

In result, there is quite usual relationship between environment and environmental enrichment as well. We observed specific influence of a social hierarchy and social dynamics in food enrichment both in chimpanzees and in gorillas (Trilčová *et al.* 2008). There is very remarkable influence of social structure composition, number of males and females, number of youngsters, social stability and "migration" i. e. introduction of new individuals and taking of maturing males or females. What we have observed is a "side" enrichment, paper package on pinatas in chimpanzees and wooden shaving in gorillas (Trilčová *et al.* 2006, Vančatová 2008). Our long term experience shows that we should study a potential of an environment of a given group for motivation and activation of a group in their stable environment (natural enrichment) instead of making of "artificial enrichment" that could be in for the group non-interesting, stressing, frustrating or easy to destroy (Vančatová, Vančata 2011, Vančatová *et al.* 1994). Age /sex structure should be taken into account as well.

One of the approaches is to implement various defined categories of food enrichment to improve living conditions of a group. For example five different categories can be used when providing enrichment. These are: 1. Play enrichment, 2. Social enrichment, 3. Cognitive enrichment, 4. Sensory enrichment, and 5. Food enrichment (COAPE 2019).

In addition to these five categories, changes that can be made to enclosures to make them more stimulating for the animals. These changes include meeting species-specific needs like climbing structures for canopy dwelling monkeys or trees for spectacled bears.

However, it is problematic to divide enrichment into categories with exception of cases of experiments like use pinatas in chimpanzees (Trilčová *et al.* 2008) or complex manipulating objects in gorillas (Vančatová 2011). Our aim is to demonstrate that environmental enrichment, namely in apes, should be more focused on a social structure and "natural" environment of a group with a stress on decision making and cognitive processes of individuals of various age and sex.

Studied group and methods

We have studied western-lowland gorilla groups (*Gorilla gorilla gorilla*), in Prague Zoo between 2001–2018. We had observed more than 1500 cases of various manipulation activities during last 8 years (2011–2018) including their context with environmental enrichment and social dynamics. A special attention was focused on variability of object using in dependence on sex, age and hierarchy as well as to the cognitive activities connected with using of various objects and tools (Vančatová 2011).

Our study of environmental enrichment is based on our case study of tool behaviour. After the analysis of the results we divided objects that can be effective enrichment in gorillas into three groups: 1. Plastic boxes and wooden baskets, 2. Wooden shaving, 3. Long tools, branches and toys.

RESULTS

Plastic boxes, baskets etc.

Spontaneous using of plastic boxes, baskets and bolls as a step-stool or seat

We have observed spontaneous using of boxes for vegetable. All females in Prague group used the plastic box as a stool to make pyramids from the boxes. All females used these boxes, baskets or bolls as a step-stool (*Figure 1*).

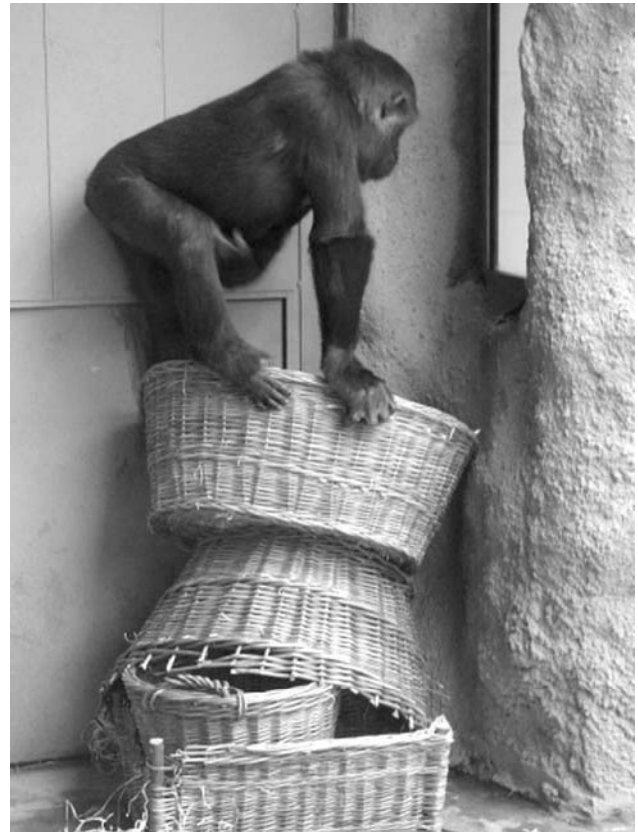


FIGURE 1: Subadult female Moja use baskets to make pyramid.

Use of a box as a table or tray

Adult male had used sometimes the box as a table or tray.

Spontaneous use of plastic boxes or other objects as weapons

Use of plastic boxes as weapons was observed during conflict situations (*Figure 2*).

Spontaneous use of plastic boxes as drums of drummers

Gorilla females in Prague Zoo group frequently drum on plastic boxes that seems to be way of play behaviour of gorillas.

Spontaneous use of plastic boxes as a drum during agonistic behaviour

Drumming was clearly agonistic and female gorillas put the box at chest in way like chest beating in conflict situation.

Use basket for hiding

Young gorillas often hide under large basket. This type of behaviour occurs during play.

The use of the plastic box for the sweeping garbage (dirt)

Using box for garbage, for example for wooden shavings or faeces.

Using plastic box as a basket

The plastic box (container) was taken to another location and defended.

Wooden shaving

Spontaneous use of wooden shaving as a pad for the hands/elbow

Gorilla females in the Zoo Praha had made those wooden shaving pads. This is in fact newly obtained

comfort behaviour improving comfort of life of a gorilla.

Spontaneous nest making

Various objects are used for nest making on the ground like wooden shaving, excelsior, parts of cloth, paper, paper boxes disassembled in parts, branches, etc. In this case wooden shaving that is a part of captive environment partially substitute usually used substrate for nest building which are the branches, part of cloth or paper which is broadly used all other great apes (*Figure 3*).

Spontaneous making of primitive slippers

One female during winter period used wooden shaving as primitive shoes for the walking on the snow or to walk across the wet part of the ground. Recently, the "wooden shaving slippers" are used by all the gorillas,



FIGURE 2: Use of plastic boxes as weapons.

The simple objects place in enclosure for gorillas initiate rare or new behavioural patterns – implications for the origin of hominine tool behaviour



FIGURE 3: Use of basket and wooden shaving to nest making.



FIGURE 4: Female used wooden shaving as primitive shoes.

youngsters used it specifically for play. This is completely new innovative behaviour that documents abilities to learn some activity as an enrichment of the environment and it demonstrate simple but very effective cognitive and sensory enrichment. It also documents origin of new specific tradition that enrich social activities in a group including development of learning abilities (*Figure 4*).

Use litter to block the photocell on drinking

Young female used wooden shaving (litter) to block the photocell for drinking fountains. Again, it demonstrates simple but very effective cognitive and sensory enrichment and development of learning abilities and probably effective play enrichment that had originated without any human influence.

The use of wooden shaving (litter) as neck protectors

Adult female gorillas used wooden shaving to protect the neck and chest when drinking.

Creating "Islands" during traveling through the new substrate place

Silverback male gorillas used wooden shaving to create "safe island" for traveling to cross new substrate in a cage. This also document a specific way of cognitive environmental enrichment and use of a "natural" part of a living environment similarly as is use of branches under natural conditions (*Figure 5*).

The use of wood wool to clean the body.

Female gorilla used wooden shaving to wipe blood. This activity is similar to use of leaves for cleaning body in chimpanzees.

Using of wooden shaving as a cushion

All gorilla females used a wooden shaving as a cushion when they are sitting on the hard surface. This is a specific innovative behaviour improving environment in captivity (*Figure 6*).



FIGURE 5: Silverback male gorillas used wooden shaving to create "safe island."



FIGURE 6: Gorilla females used a wooden shaving as a cushion.

The simple objects place in enclosure for gorillas initiate rare or new behavioural patterns – implications for the origin of hominine tool behaviour

Using wooden sticks etc.

Spontaneous use of a branch to reach food

Gorillas took a branch in secluded area to reach the food (*Figure 7*).

Spontaneous use of part of tree as a ladder

Females use of part of tree as a ladder inside the exposition.

Using of the stick for the contact of other gorillas.

Adult females or juveniles use the stick for the contact other individuals (*Figure 8*).

Making tools and their use in experimental situations

Silverback male was offered by wooden objects with hollows with dried fruits were in those hollows. He used a small stick to get fruits from the hollows.

DISCUSSION

In our opinion, it is problematic to divide type of enrichment according to some specific objective. For example, locomotor enrichment is in most cases also a playing, social and possibly food enrichment – allowing low-ranking individuals to eat food at rest. Wooden shaving or plastic boxes has become the cognitive enrichment in our case. The character of the enrichment depends on the age and sex structure of the group, the hierarchy and the number of ovulating females.

However, these factors cannot be predicted beforehand, but conditions for them can be created. In our case, for example, food enrichment, such as vegetable fruit cakes, has always been the subject of monopolization of high ranking males, and therefore



FIGURE 7: Subadult gorilla took a branch to reach the food.



FIGURE 8: Young gorilla male uses the stick for the contact with silverback male.

it was necessary to provide enrichment in several places of secluded area, which *de facto* enriched the social dynamics of the group (Tennie *et al* 2008, Trilčová *et al.* 2006, 2008, Vančátová 2011).

Play enrichment in the apes cannot be based on contact with people or on the submission of toys to the youngsters. Toy must be put into the secluded area without any contact and we must wait if the object becomes spontaneously a subject of manipulation which in fact simulates situation under natural conditions. The subject of play behaviour often consisted of items commonly occurring in the enclosure, such as plastic boxes or baskets, which, however, were used in a certain way by the whole group, including the dominant silverback male. Our long-term study of the gorillas group in Prague shows that appropriately selected enrichment elements become multifunctional as a rule (Vancatova 2008, 2011). Chimpanzees have a number of such multifunctional elements, both in the wild and in

captivity, however, such elements have not been expected in captive gorillas (Tennie *et al.* 2008).

The multifunctionality of the elements of enrichment depends on the degree of creativity, which is excellent in the apes. Here is the enrichment to a large extent the determination of "self-attractiveness" of objects including the development of cognitive processes which is very well demonstrated by the use of plastic boxes but it is best demonstrate by multifunctional using of wooden shaving.

It follows that "artificial" enrichment is much less effective than in the case when elements of enrichment become part of the group's traditions – see the gorilla's research (Vančátová 2011) which is consistent with the hypothesis of evolutionary development of ape cognition (Potts 2004). The enrichment of the environment in the gorilla originally mainly concentrated on the locomotor enrichment, that is, resistant objects mostly wooden or ropes, and so on. Further diversification had a rather experimental

nature, plastic boxes were used first, and then wooden baskets. The use of these subjects was significantly influenced by age, sex and, in some cases, the social status of the individual. Another enrichment element, a wooden shaving, has surprisingly shown, that this substrate was used not only for nesting activities, but also for many other purposes. Such use had the character of cognitive and play enrichment (blocking the sensor at the drinking fountains), sensory enrichment – wooden shaving shoes, social enrichment – learning of the making and use wooden shaving shoes in the group.

CONCLUSIONS

It can therefore be summarized that the enrichment of the environment in apes should not be based on defined categories of enrichment, but on the complexity of enrichment and on stimulation of spontaneous activities of the different age and sex groups which has been documented in many chimpanzee studies (Hicks *et al.* 2019, Koops *et al.* 2013, 2014, Vančátová 2008, 2011). Further development of the environmental enrichment needs to be modified according to the hierarchy in social structure and social dynamics. Youngsters in the group age are growing old, adults are ranking a certain place in the social hierarchy, and secluded area use to be also adapted according to the possibilities and needs of the group. Thus, the optimal enrichment of the environment should be long-term motivating and appropriate for all/most group members.

We can conclude that "spontaneous" environmental enrichment, that gives a free decision options to any individual member of a group, could help us to understand to the origin and early development and formation of early hominine tool activities including relations among adaptive value of tools and evolution of early hominine cognition.

ACKNOWLEDGMENTS

The authors wish to thank to many colleagues and zoo-keepers from Prague Zoo (Miroslav Bobek, Jana Myslivečková, Marek Ždánský). The research was partially supported by Progress funding (PVOUK P15, Q17). Special thanks are to authors of photos: Rozhlas CZ, Odhalení, Miroslav Bobek, Marie Fárová, Jan Kadeřábek, Lucie Štěpničková.

REFERENCES:

- ALP R. 1997: "Stepping-sticks" and "seat-sticks": new types of tools used by wild chimpanzees (*Pan troglodytes*) in Sierra Leone. *American Journal of Primatology* 41: 45–52.
- BIRO D., NAKAMURA N. I., TONOOKA R., YAMAKOSHI G., SOUSA C., MATSUZAWA T., 2003: Cultural innovation and transmission of tool use in wild chimpanzees: evidence from field experiments. *Animal Cognition* 6: 213–223
- BOESCH C., 2012: *Wild Cultures: A Comparison between Chimpanzee and Human Cultures*. Cambridge, CAMBRIDGE UNIVERSITY PRESS.
- CARVALHO S., BIRO D., MCGREW W. C., MATSUZAWA T. 2009: Tool-composite reuse in wild chimpanzees (*Pan troglodytes*): archaeologically invisible steps in the technological evolution of early hominins? *Animal Cognition* 12: 103–114.
- CELLI M. L., HIRATA S., TOMONAGA M. 2004: Sociocological influences on tool use in captive chimpanzees. *International Journal of Primatology*, 25(6): 1267–1281.
- COAPE: JHB Zoo Enrichment Programme, 2019: <https://www.coapesa.com/jhb-zoo-enrichment-programme/>
- DEBLAUWE I. 2009: Temporal variation in insect-eating by chimpanzees and gorillas in southeast Cameroon: extension of niche differentiation. *International Journal of Primatology* 30: 229–252.
- DUTTON P., CHAPMAN H. 2015: New tools suggest local variation in tool use by a montane community of the rare Nigeria-Cameroon chimpanzee, *Pan troglodytes ellioti*. *Nigeria. Primates* 56: 89–100. <https://doi.org/10.1007/s10329-014-0451-1>
- HARMAND S., LEWIS J. E., FEIBEL C. S., LEPRE C. J., PRAT S., LENOBLE A., BOËS X., QUINN R. L., BRENET M., ARROYO A., TAYLOR N. 2015: 3.3-million-year-old stone tools from Lomekwi 3, West Turkana, Kenya. *Nature* 521: 310–315. <https://doi.org/10.1038/nature14464>.
- HAYASHI M., MIZUNO Y., MATSUZAWA T., 2005: How does stone-tool use emerge? Introduction of stones and nuts to naive chimpanzees in captivity. *Primates* 46: 91–102
- HICKS C. T., KÜHL H. S., BOESCH C., DIEGUEZ P., AYIMISIN A.E., FERNANDEZ R.M., ZUNGAWA D. B., KAMBERE M., SWINKELS J., MENKEN S. B. J., HART J., MUNDY R., ROESSINGH P., 2019: Bili-Uéré: A Chimpanzee Behavioural Realm in Northern Democratic Republic of Congo. *Folia Primatologica* 90: 3–64. doi: 10.1159/000492998
- KOOPS K., MCGREW W. C., MATSUZAWA T., 2013: Ecology of culture: do environmental factors influence foraging tool use in wild chimpanzees, *Pan troglodytes verus*? *Animal Behaviour* 85: 175–185. DOI: 10.1016/j.anbehav.2012.10.022
- KOOPS K., VISALBERGHI E., VAN SCHAIK C., 2014: The ecology of primate material culture. *Biology Letters* 10: 20140508. doi: 10.1098/rsbl.2014.0508
- KURODA S., NISHIHARA T., SUZUKI S., OKO R., 1996: Sympatric chimpanzees and gorillas in the Ndoki Forest, Congo. In: W. C. McGrew, L. F. Marchant, T. Nishida

- (Eds.): *Great Ape Societies*. Pp. 71–81. Cambridge, Cambridge University Press.
- LANGERGRABER K., BOESCH C., INOUE E., INOUE-MURAYAMA M., MITANI J., NISHIDA T., PUSEY A., REYNOLDS V., SCHUBERT G., WRANGHAM R. W., WROBLEWSKI E., VIGILANT L., 2010: Genetic and "cultural" similarity in wild chimpanzees. *Proceedings of the Royal Society B: Biological Sciences* 278: 408–416. DOI: 10.1098/rspb.2010.1112
- LONSDORF E. V., ROSS S. R., LINICK S. A., MILSTEIN M. S., MELBER T. N., 2009: An experimental, comparative investigation of tool use in chimpanzees and gorillas. *Animal Behaviour* 77: 1119–1126.
- LUNCZ L. V., WITTIG R. M., BOESCH C., 2015: Primate archaeology reveals cultural transmission in wild chimpanzees (*Pan troglodytes verus*). *Philosophical Transactions of the Royal Society B* 370: 20140348. DOI: 10.1098/rstb.2014.0348
- LUTZ C. K., NOVAK M. A., 2005: Environmental enrichment for nonhuman primates: Theory and application. *ILAR Journal*, Pp. 1–21, Oxford Academic.
- MERCADER J., PANGER M., BOESCH C., 2002: Excavation of a chimpanzee stone tool site in the African rainforest. *Science* 296: 1452–1455.
- MILLER G., 2005: Tool Study Supports Chimp Culture. *Science* 309: 1311.
- MULCAHYN J., CALL J., DUNBAR R. I. M., 2005: Gorillas (*Gorilla gorilla*) and Orangutans (*Pongo pygmaeus*) Encode Relevant Problem Features in a Tool-Using Task. *Journal of Comparative Psychology* 119, 1: 23–32.
- NAKAMICHI M., 1999: Spontaneous use of sticks as tools by captive gorillas (*Gorilla gorilla gorilla*). *Primates* 40: 487–498.
- POTTS R., 2004: Paleoenvironmental Basis of Cognitive Evolution in Great Apes. *American Journal of Primatology* 62: 209–228.
- TENNIE C., HEDWIG D., CALL J., TOMASELLO M., 2008: An Experimental Study of Nettle Feeding in Captive Gorillas. *American Journal of Primatology* 70: 1–10.
- TRILČOVÁ J., MARVÁN R., POLÁK T., TENNIE C., VANČATA V., 2008: Preferable and Predictable Enrichment in Captive Common Chimpanzees: How Affiliative and Agonistic Behavioural Patterns May Be Elicited Via Piñatas Enrichment Device. *Folia Primatologica*, 79: 391.
- TRILČOVÁ J., MARVÁN R., TENNIE C., VANČATA V., 2006: Effects of food enrichment on chimpanzee affiliative and agonistic behaviour. *Primate Report* 73,1: 41.
- VAN CASTEREN A., WRIGHT E., KUPCZIK K., ROBBINS M. R., 2019: Unexpected hard-object feeding in Western lowland gorillas. *American Journal of Physical Anthropology* 2019: 1–6. <https://doi.org/10.1002/ajpa.23911>
- VANČATOVÁ M., 2008: Tool behaviour in higher primates. *Vestník NGU* 2, 2: 61–69.
- VANČATOVÁ M., 2011: *Tool behaviour in higher primates: From manipulation activities to tool using*. PhD theses. Brno, Masaryk University, 218 pp.
- VANČATOVÁ M., VANČATA V., 2011: Introduction of a group of *Hamadryas* baboons from Zoo to Island, St. Petersburg, Russia: A case study of individual changes in behaviour and locomotion. *Antropologie (Brno)* XLIX/1: 21–26.
- VANČATOVÁ M., VANČATA V., JEBAVÝ L., 1994: Influence of environmental changes on the behaviour of macaques. In: *XVth Congress of the Intern. Primatol. Soc.*, 1994, Kuta – Bali, Indonesia. Handbook and Abstracts, p. 157.
- VAN SCHAIK C. P., KNOTT C. D., 2001: Geographic variation in tool use on *Neesia* fruits in orangutans. *American Journal of Physical Anthropology* 114: 331–342.
- VOGEL G., 2002: Can Chimps Ape Ancient Hominid Toolmakers? *Science* 296: 1380.
- WITTIGER L., SUNDERLAND-GROVES J. L., 2007: Tool use during display behavior in wild Cross River gorillas. *American Journal of Primatology* 69: 1307–1311.

Vančatová Marina
Green Pilgrims
Non-profit organization

Vančata Václav*
Charles University in Prague
Czech Republic
E-mail: vaclav.vancata@gmail.com

*Corresponding author.